OLEUM
SSING

l Processing Section

9 5 2

Progress in Petrochemicals

Industry's future analyzed by study of major raw materials sources—p. 641

Automatic Sulfur Recovery Plant

There's a profit in this 20 ton/day unit through lower manpower—p. 648

HUDSON SOLO-AIRE EXCHANGERS

Pictured above is an installation of HUDSON SOLO-AIRE JACKET WATER COOLERS providing cool water to the power cylinders, compressor cylinders, and lubricating oil coolers of ten 800 horsepower gas engine driven compressors. The coolers, using air as the cooling medium, and operating with inlet air temperatures ranging seasonally from below zero to 105° F, deliver cool jacket water at a *uniform, controlled* temperature the year around.

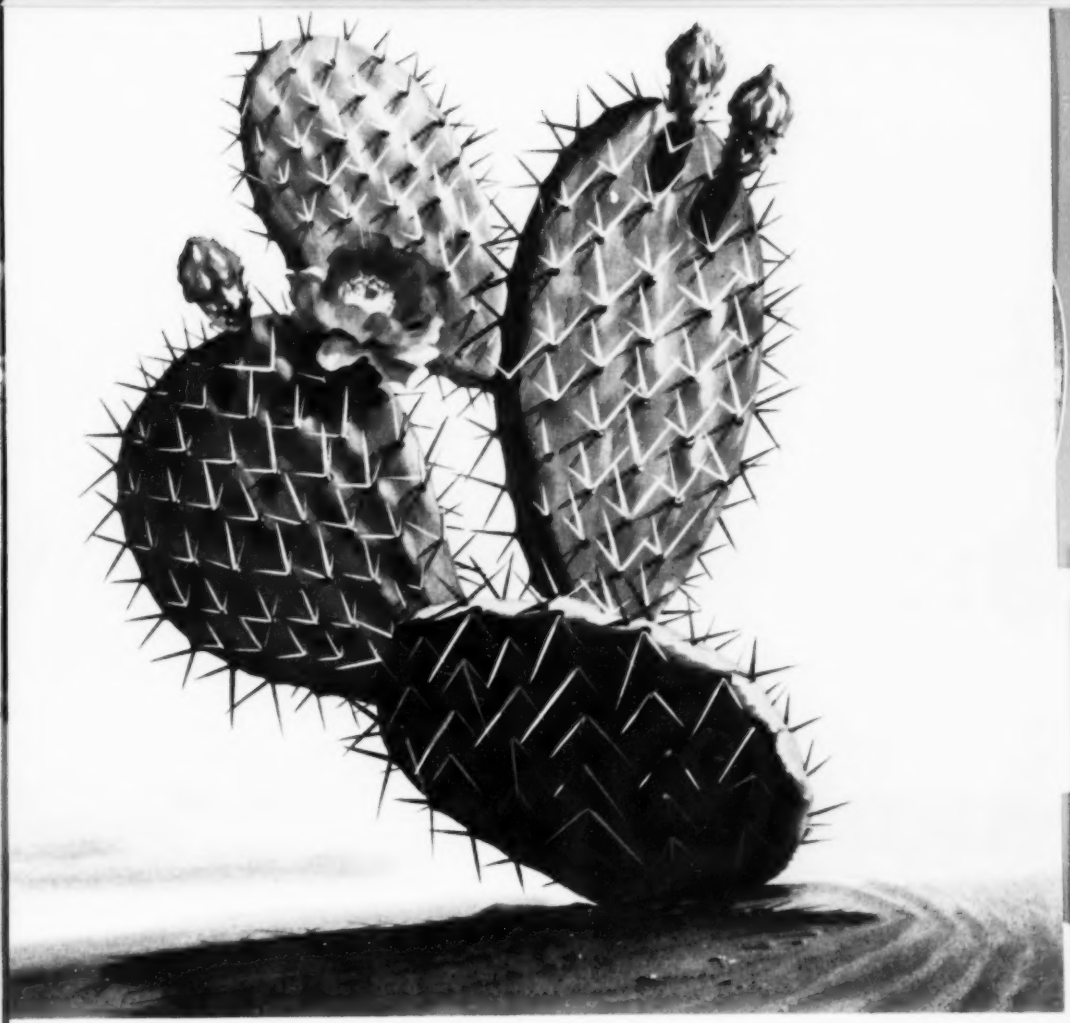
For this installation the great expense of obtaining and treating raw water determined the selection of HUDSON SOLO-AIRE units—rather than HUDSON water cooling tower with HUDSON water-cooled units. The use of air-cooled units in this compressor station precluded the loss through evaporation of about 90 gallons per minute of raw water.

HUDSON SOLO-AIRE units are in use in a great variety of process cooling and condensing services in chemical plants, refineries, and gas processing plants.

OTHER HUDSON "TP" COOLING EQUIPMENT

Bulletins on HUDSON TOP PERFORMANCE COOLING EQUIPMENT mailed upon request

HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION • HOUSTON, TEXAS



What is the most important point about our new Texas plant?

It probably would be more usual to announce the opening of Ethyl's new Texas plant by showing a large air view of the entire layout. However, this close-up of another kind of Texas plant better illustrates our point.

You see, the plant in the picture above is completely self-sustaining. Just give it sunlight, air, a little water, and a place to grow. It depends only upon raw materials to make the complex chemicals it needs to stay in business. In other words, it is a *completely integrated* plant . . . just like the new Ethyl plant at Houston, Texas.

Give Ethyl's new Texas plant the raw materials—such as pig lead, salt, petroleum gases, electricity—and it can make all the chemical ingredients needed in "Ethyl" antiknock compound. In this way the new plant is like Ethyl's plant

(*continued on next page*)

ETHYL
ETHYL CORPORATION

What is the most important point about our new Texas plant?

continued from preceding page

at Baton Rouge. Each is completely integrated — and is independent of the other.

We think this integration is an extremely important point to refiners. Today refiners are faced with the challenge of supplying great quantities of high-quality gasoline to meet the ever-increasing demands of American transportation. To perform this service, they need an uninterrupted supply of antiknock compound which an *integrated* plant is best able to give them.

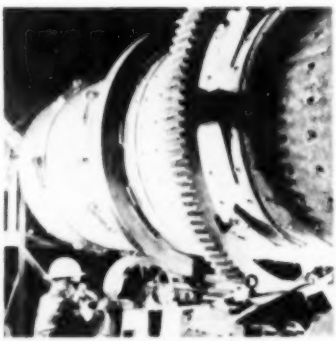
With the construction of Ethyl's new Texas plant, such a reliable source of antiknock compound is now assured. The new plant is engineered for highest efficiency. Raw materials are available nearby. Electric power supplies are ample. Six railroads out of Houston give Ethyl wide choice in routing antiknock compounds to Ethyl customers throughout the country. And, perhaps most important, this new plant has expanded facilities to a point where "Ethyl" antiknock compound manufacturing capacity is now more than ample to meet demand in the foreseeable future.

ETHYL CORPORATION

NEW YORK 17, NEW YORK

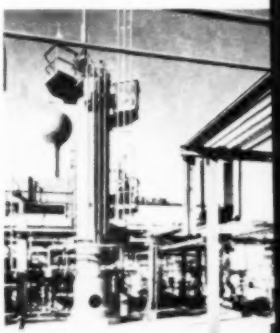
Ethyl service is backed by 29 years of antiknock experience

HERE ARE A FEW OF THE MANUFACTURING UNITS IN OUR NEW TEXAS PLANT



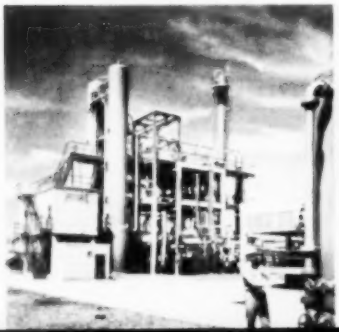
A SALT DRYER IN THE SODIUM BUILDING

HIGH-VOLTAGE LINE FOR SODIUM CELLS

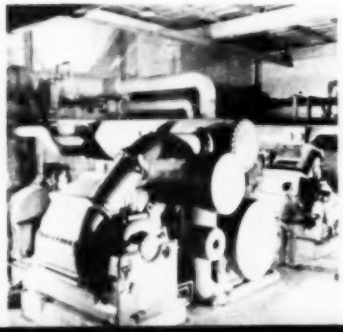


THIS IS THE ETHYL DICHLORIDE PLANT

THE ETHYL CHLORIDE UNIT IS A PLANT IN ITSELF

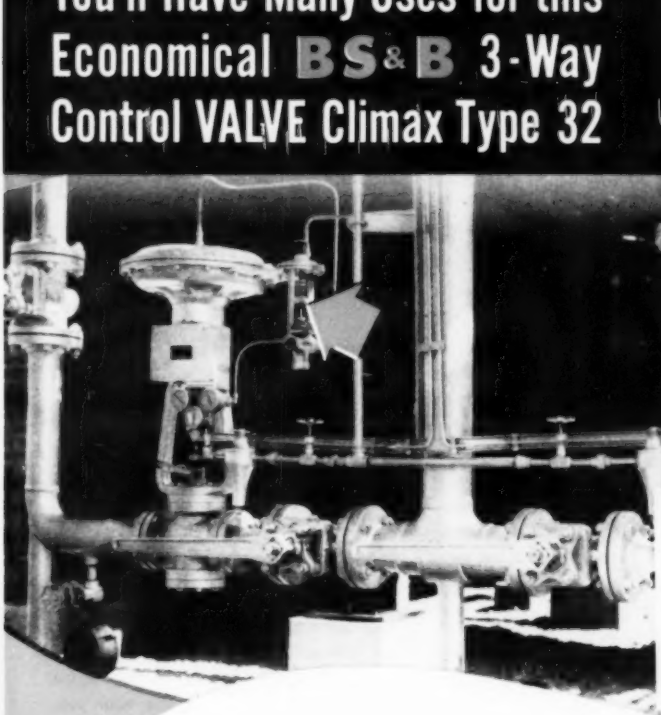


REFRIGERATION COMPRESSORS IN THE ETHYL CHLORIDE UNIT



TETRAETHYLLEAD MANUFACTURING BUILDING

You'll Have Many Uses for this Economical BS&B 3-Way Control VALVE Climax Type 32



IN THE REFINERY OR GASOLINE PLANT...

Type 32 RMC Control Valves (with manual reset) used as low pressure emergency shut-off with Type 86 Climax valves on fuel gas line in an Oklahoma Cycling Plant.

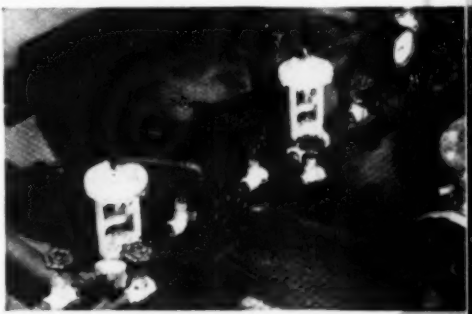
Designed for service with low differential pressure across the valve, having a small diaphragm area, Climax Type 32 Control Valve is both economical and versatile. As a three-way valve the spring holds the upper or horizontal ports closed when control medium is not applied to the diaphragm; as pressure is applied, the upper port opens for straight-through flow and the lower port closes.

To convert Type 32 to an inexpensive control or direct regulator it is only necessary to plug one of the valve outlets. Thus, with one horizontal outlet plugged (Type 32-D) with the bottom outlet plugged (Type 32-R). With these easy modifications you have, within their capacities, very efficient control valves, reducing regulators or back pressure valves. The Type 32 with hookup variations will serve many unique applications in safety shutdown systems or alarm signals.

The cast iron body, stainless steel inner valve and Neoprene diaphragm make Type 32 a rugged *and* versatile adjunct to your controls system.

IN THE FIELD...

Climax Type 32-R valves used as automatic pressure controls to shut down pumps supplying low-pressure separator on Gulf tidelands platform at over-pressure or pressure drop.



WRITE FOR Complete Literature on Type 32 and other Climax Diaphragm Control Valves. Ask for Catalog Section 105. Your nearest BS&B branch office has an expert on Climax Controls to assist you with your problems.

CLIMAX BS&B CONTROLS

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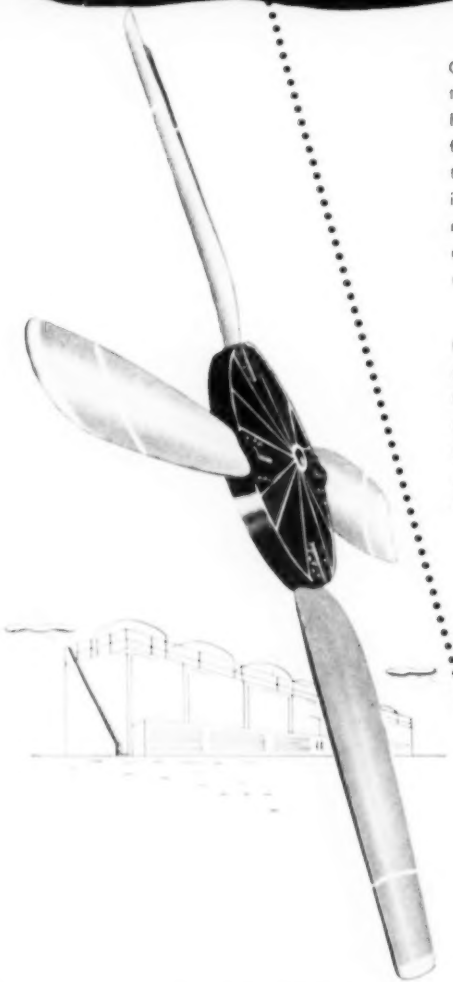
HARTZELL COOLING TOWER FANS

--dependability under the worst of weather and wear



Corrosion, vibration, abrasion. These are the big headaches of the cooling tower fan operator. And these are the problems Hartzell engineers consider when they design cooling tower fans. The exclusive Hartzite plastic blade makes this fan practically impervious to acid and alkali corrosion and weathering; it greatly reduces the possibility of vibration damage. A plastic reinforcement at the base of each blade prevents concentration of flexing at the shank. And the rugged Hartzell hub packs tremendous strength—far beyond any calculable needs.

Sizes that range from 10 feet to 22 feet in diameter give the cooling tower operator the opportunity to select exactly the *right* type of fan for his installation. If you are in doubt as to the type of fan to use—call your Hartzell field engineer for the answer. Regardless of your location, there's one near you. Or, if you desire more information, write for the newly revised bulletin 1503 which gives the details about Hartzell cooling tower fans.

Blade and hub construction used on the 14 to 22 foot models.

Blade and hub construction used on the 10 to 13 foot models.

CLIP AND MAIL THIS COUPON NOW FOR INFORMATION

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PETROLEUM PROCESSING

Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

May, 1952
Vol. 7, No. 5

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1213 West Third St., Cleveland 13, O.

Editorial Staff

Virgil B. Guthrie, *Editor*
50 West 50th St., New York 20.

William F. Bland, *Engineering Editor*

William C. Uhl, *Equipment Editor*

D. P. Thornton, Jr., *Southwestern Editor*
810 First Nat'l. Bank Bldg., Houston 2.

Frank Breese, *West Coast Editor*
416 West 8th St., Los Angeles 14.

Andrew R. Patla, *Washington Editor*
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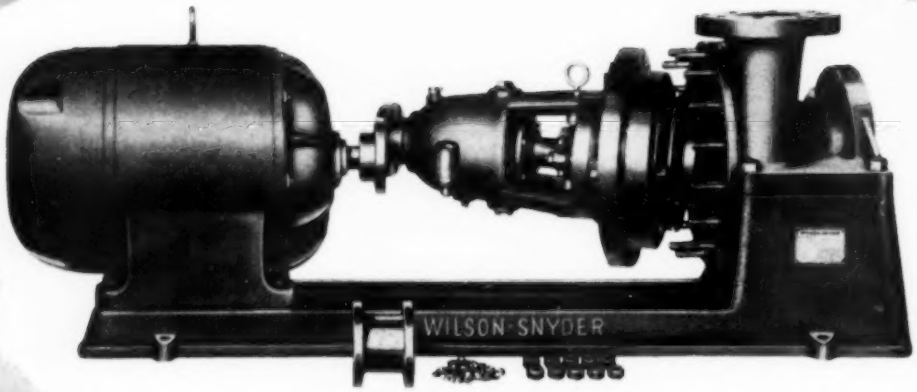
Look how EASY it is...
to dismantle for inspection or repair



Wilson-Snyder Type ES Centrifugal Process Pumps

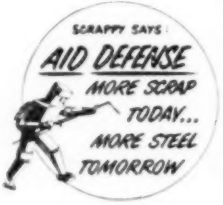
BY REMOVING the coupling spacer and nuts from the case parting flange, Wilson-Snyder Type ES single-stage, single-suction process pumps, with vertically split case, can be dismantled for inspection without disturbing the driver or the piping.

These pumps are specifically designed for services where:

1. **continuity of operation is very important**
2. **temperatures or pressures may be very high**
3. **hot or cold liquids are handled near their boiling points**
4. **broad capacity range at high efficiency is desirable**

Design permits maximum interchangeability of parts. Only 3 sizes of bearing brackets, sleeves, packings, shafts and bearings are required for all 18 pump sizes, which provide capacity ranges from 40 to 1800 gpm with differential heads from 40 to 1000 feet and a speed range from 1750 to 4000 rpm with horsepower range from 2 to 250.

"Trims" can be furnished of any commercially available material which can be cast and machined, but standard stock materials include (a) 40,000-pound tensile cast iron, (b) low carbon cast steel, (c) 13% chrome stainless, type 410, (d) 18-8 stainless, types 304 and 316, (e) acid-resisting bronze, (f) 18-8 Stellited wear faces, (g) 4140 HT shaft and studs and (h) spark proof monel glands.



FOR FULL INFORMATION . . . or quotations on Wilson-Synder Process Pumps, contact "Oil-well's" nearest refinery specialist at area office points shown below.

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Publisher's Page

Your subscription price? Reading time only

Dick Loyer, our circulation manager, recently completed a swing through the Southwest to arrange for distribution of PETROLEUM PROCESSING to qualified men in petrochemical companies and plants in that area in line with our expanded editorial coverage of petrochemical operations. The men Dick contacted expressed considerable surprise at our ability to provide free copies of PETROLEUM PROCESSING to their key technical and supervisory men.

Actually, we're not being beneficent in our distribution of this magazine. As a recipient of PETROLEUM PROCESSING you are a member of a rather exclusive group—a group of hand-picked men in the petroleum and petrochemical processing industries. Your position in your company has earned you the right to receive your personal copy without charge every month.

There are only 14,000 other men like you in this vast processing industry. You have all been selected by your company managements as important factors in determining the product characteristics, plant design and operations that lead to the purchase of the varied products and services used in petroleum and petrochemical processing. The only "dues" that you or your companies pay for your membership in this select group of our readers is the time you devote to the readership of each issue of PETROLEUM PROCESSING. Making this investment of your reading time pay off for you is the primary objective of our editorial staff.

The subscription prices charged for magazines and newspapers are incidental in defraying the total publication costs. This is particularly true among business publications. The cost of just printing and mailing additional copies greatly exceeds the average subscription price. In fact, the cost of just selling new subscriptions nearly always exceeds the resulting subscription income.

Many business paper publishers continue to charge subscription prices for their magazines despite their complete dependence on advertising revenue—in order to have a dollar and cents measurement of continued reader interest. This gauge is misleading today due to the growing practice of company multiple subscriptions.

We believe that through selective distribution of PETROLEUM PROCESSING to key men like you throughout this industry we can better and more economically serve our advertisers and the industry we represent. By the employment of new and improved surveying methods for measuring reader reaction, our editors can more accurately determine your reader interests and requirements to make your reading of PETROLEUM PROCESSING profitable to you.

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A. W. Boulton

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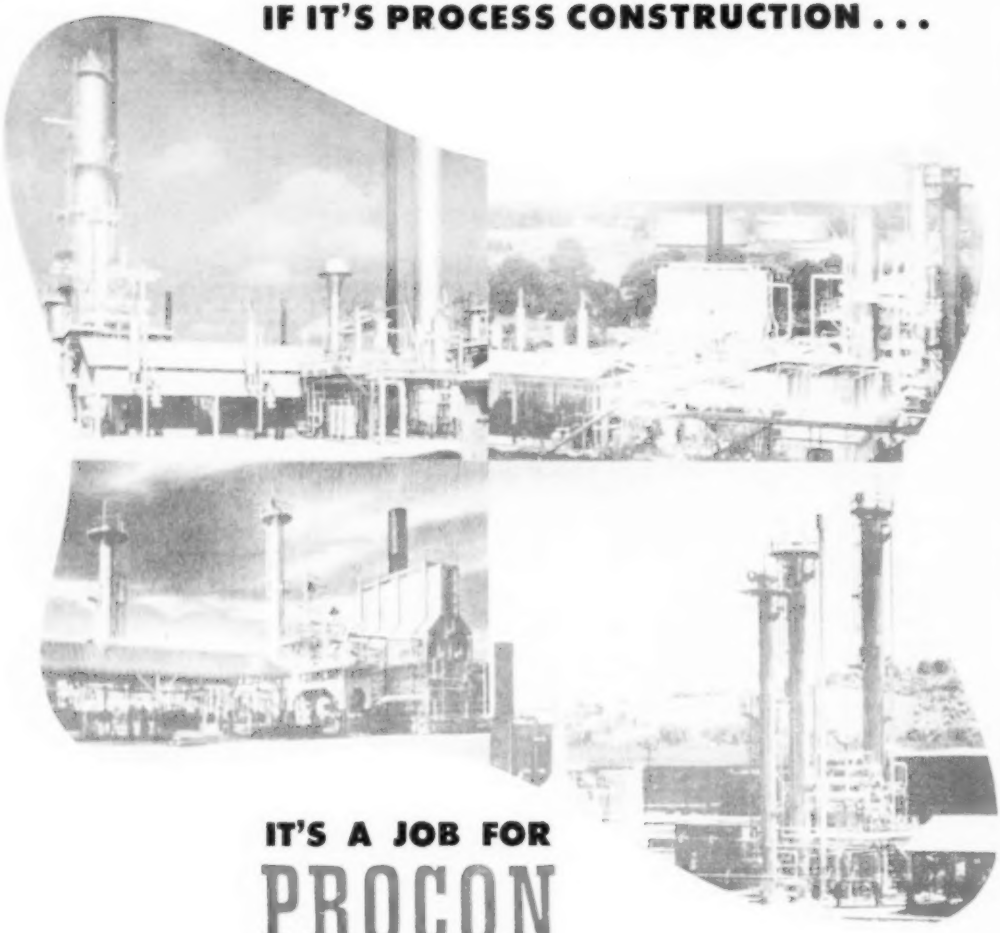
Platt's Oilgram Prices
A daily independent oil-price reporting service issued from New York, Cleveland and Houston.

IF IT'S PROCESS CONSTRUCTION . . .



IT'S A JOB FOR

PROCON

For example—cat crackers . . . Platforming units . . . fractionating systems . . . vis-breakers . . . aromatic extraction units . . . gas recovery systems . . . and other types of processing units and plants. This partial list of current jobs is a clear indication of Procon's ability to handle any type of process construction work.

Procon has the broad range of experience plus the necessary flexibility to give you the advantage of a complete, practical and efficient construction service.

PROCON *Incorporated*

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PROCESS CONSTRUCTION

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What's Happening . . .

Expansion

. . . **Frontier Oil Refining Corp.** has started $6 million expansion program at refinery near Tonawanda, N. Y., involving a crude throughput increase to 25,000 b/d, and a new 13,000 Fluid catalytic cracking unit. Arthur G. McKee & Co. will build the Fluid unit. Catalytic Construction Co. has contract for auxiliaries and off-site facilities, including poly plant revamping, new kerosine treater boiler house, and loading facilites.

. . . **Pan-Am Southern Corp.** reports constructon has begun on first commercial Fluid hydroformer, 2000 b/d capacity, at Destrehan, La., refinery. M. W. Kellogg Co. has contract. Completion is scheduled for August, 1952. (What's Happening, July, '51, p. 691).

. . . **General Petroleum Corp.** was slated to start erection of a $50,000 engineering building May 1 at its Torrance, Calif., refinery; construction being handled by P. J. Walker Co.

. . . **Imperial Oil Co., Ltd.,** has awarded Canadian Bechtel, Ltd., Vancouver, contract for major part of $13.5 million construction program at its Ioco refinery, increasing capacity from present 12,000 to 22,500 b/d. Construction will start in early fall, for completion in the fall of 1953. (What's Happening, Jan., '52, p. 7).

. . . **Col-Tex Refining Co.,** jointly-owned plant of Anderson-Pritchard Oil Corp. and Standard Oil Co. of Calif., plans to install a Platforming unit at its Colorado City, Texas, refinery.

. . . **Elk Refining Co.** is building a 1500 b/d Platformer at Falling Rock, W. Va. Company has absorbed the complete wholesale and retail marketing facilities of Pennzoil in state outside of Wheeling area.

. . . **Continental Oil Co.** will build a $1,750,000 gasoline recovery and gas repressuring plant in Johnson county, Wyo., in the Sussex oil field. Construction is expected to start in late summer. Company anticipates the recovery during a 20-year period to total over a million bbls. of oil, and make available 13 billion cu. ft. of natural gas and 300,000 bbls. of natural gasoline. Plant will tie in with Platt Pipe Line, now building.

Foreign

. . . **Compania Espanola de Petroleos S.A.,** will install a 5000 b/d Platformer at Santa Cruz, Tenerife, Canary Islands; design by Universal Oil Products and construction by Procon, Inc. Unit is scheduled for completion in late 1953 or early 1954, and will operate seven days per stream month to produce aromatics from Venezuelan crude, other 23 days to produce motor fuel from Kuwait stock plus Venezuelan naphthas left from aromatics operation.

. . . **Anglo-Iranian Oil Co.'s** refinery to be built at Kwinana, near Fremantle, West Australia, will have capacity of 60,000 b/d, largest in the country. It will include atmospheric and vacuum stills, catalytic cracking, and treating units.

. . . **Conselho Nacional do Petroleo** will double present 2500 b/d refinery at Mataripe, Bahia, Brazil. Catalytic polymerization is being added along with modifications to existing plant. M. W. Kellogg is engineer-contractor, with Kellogg Pan-American Corp., supervising construction.

Petrochemicals

. . . **Standard Oil Co. (Indiana)** has awarded M. W. Kellogg contract to build 10 million lbs./yr. iso-octyl alcohol plant at Wood River, Ill. Plant has three basic parts: fractionation system and refinery gas reformer to be designed by Kellogg, and iso-octyl alcohol section designed by Indiana Standard. Plans call for completion before end of 1952 (What's Happening, July, 1951, p. 691). A heavy duty motor oil detergent additive plant for Wood River is also in design stage, with completion contemplated for 1953.

. . . **Lion Oil Co.** is planning a $31 million ammonia-from-natural gas plant at Luling, La. (near New Orleans) to produce 300 tons daily of anhydrous ammonia, most of which will be converted into prilled ammonia nitrate. Natural gas will be supplied by The Texas Company; a DPA certificate has been granted for about 50% of the cost. When completed, new plant will increase Lion's nitrogen manufacturing capacity about 53%.

. . . **Spencer Chemical Co.'s** $15 million ammonia plant now under construction at Vicksburg, Miss., will produce 200 tons of gaseous ammonia daily for use as fertilizer when completed. Contracts have been awarded to Air Products Inc, of Allentown, Pa., to design, manufacture and install key processing equipment at a cost over $1 million. The process involves the partial oxidation of natural gas with oxygen. One hundred eighty tons of oxygen and 310 tons of nitrogen per day will be extracted from the air by the unit.

. . . **Jefferson Chemical Co. Inc.'s** nonyl phenol and dinonyl phenol manufacturing facilities at Port Neches, Tex., are scheduled for completion within the next two or three months. Certificate of necessity has just been approved. Construction was begun last September.

. . . **Humble Oil & Refining Co.'s** projected paraxylene plant at Baytown, Tex., will be under construction by September by the builder, C. F. Braun Construction Co. Plant is scheduled for completion by May '53. It is expected to produce more than two

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

million lbs. of paraxylene a month. Humble's process, one of separation and purification, proved its effectiveness when 2000 lbs. of paraxylene a month were produced in the refinery's pilot plant. Paraxylene is one of the chief raw materials of "Dacron," a new synthetic fiber, valuable in clothes manufacturing.

. . . **Blaw-Knox Co.,** Chemical Plants Div., has been licensed by Socony-Vacuum Oil Co. to use their technical information and processes pertaining to the catlytic reforming of petroleum hydrocarbons. Agreement supplements previous license allowing Chemical Plants Div. to design and build catalytic cracking plants using Socony-Vacuum's patented processes.

. . . **Sun Oil Co.** intensified future petrochemical plans by incorporating a new amendment to the company charter at last month's annual stockholder's meeting, a move which permits them to engage in the further manufacture and sale of chemicals. Sun is now producing benzene, toluene, and xylene at their Marcus Hook refinery.

. . . **Dow Chemical Co.'s** $2,600,000 laboratory and research center contract has been awarded to Southwestern Construction Co. of Houston. The new center will be constructed at the company's Freeport location and is expected to be completed within 15 months. The eight-building center will house research, chemical engineering research, electro-chemical research and analytical laboratory facilities of Dow's Texas division. Also included are research administrative offices, a patent office, and library.

Markets, Prices

. . . **Ample supplies for spot requirements** were indicated in most refining districts during April. Prices were firm and supplies closely held on East and West coasts. On other hand, undiminished surplus of most products resulted in lower quotations for light and heavy fuel oils throughout the Mid-Continent and in Chicago refining district.

. . . **"Buyer's market" trend was coupled with large demands** in many districts. Countries whose supplies have been cut off in Iran reportedly were prepared to buy 25 cargo lots of distillate fuel oil at the Gulf in May and June. The Armed Services Petroleum Agency was also in the market for over 25 million bbls. of grade 91-96 Avgas and JP-3 and 4 jet fuels during fiscal year starting June 1, for military activities.

. . . **Kerosine and other distillate prices eased:** for Group 3, refiners' quotations slipped 0.125c on these products and 10c bbl., to $1.35, for No. 6 fuel. Kerosine was quoted at 8.75c and No. 2 fuel at 7.875c; spot quantities were available at "discounts" up to 0.75c gal.

No price changes were reported for crude and most specialties. Above-ground inventories, on the rise nationally throughout the month, assured plentiful supplies. Natural gasoline, some midwestern lube oils, and LPG continued abundant. Situation could change overnight, with strike deadline at hand as this issue went to press.

Industrial Mobilization

. . . **Structural steel supply should ease** in third quarter. PAD will get 80,000 tons, (within 7000 of amount requested) as compared with 51,480 received for second quarter, according to DPA breakdown of allocations to various claimant agencies.

. . . **Priorities assistance approvals by PAD,** up to March 28, had reached total of 665 refining projects, valued at over $1,124,000,000; and for gas 1747 projects valued at over $1,349,000,000.

. . . **"B" refining equipment should exceed demands** of oil industry's 18-month expansion program, according to Washington materials experts. They emphasized, however, that most items are still tight; particularly large motors, boilers, and switch gear, because of large demand by atomic energy program and other defense industries.

. . . **Military jet fuels needs are up** nearly 9 million bbls. for 1953, while regular avgas rose only about 1.3 million, according to Armed Services Petroleum Purchasing Agency requirements submitted to PAD recently. Total for JP-4 and JP-3 was about 22.5 million bbls.

. . . **Expansion goals on six petrochemicals** have been set by Defense Production Administration: synthetic methanol, 226 million gals. by Jan. 1, '55, 52 million gals. over Jan. 1, '51; formaldehyde, 1,675 million lbs., a 350 million lb. increase; ethylene glycol, 850 million lbs., a 327 million lb. increase; ethylene oxide, 969 million lbs., a 423 million lb. increase; carbon black, 2,320 million lbs., an 800 million lb. increase; butadiene, 162 million lbs. by Jan. 1, '54, an increase of 101 million lbs. Except for carbon black, DPA has received sufficient applications for rapid tax amortization to bring production capacities for each of these chemicals up to the goals set. In carbon black, certificates of necessity have been approved calling for 556 million lbs. of increased capacity, against the 800 million lbs. needed.

Transition

. . . **Ute Oil & Refining Co.** sold its 1000 b/d Graham, Tex., refinery to E. R. Marchman of Graham and is purchasing a 2500 b/d plant at Prewitt, New Mexico, from Petroleum Products Refining Co. Prewitt plant capacity will be hiked to about 10,000 b/d next fall.

. . . **Mid-West Refineries, Inc.,** has purchased remaining 25% of Michigan-Ohio Pipeline Corp. from Standard Oil Co. (Ohio). It had owned 75% of stock since Sept., 1950. Property comprises 260-mile crude line from Toledo, Ohio, to central Michigan.

. . . **Shell Chemical Corp.** has completed arrangements to purchase the stock of Julius Hyman & Co., and an agreement with Velsicol Corp. for exclusive rights world-wide, to aldrin and dieldrin, agricultural insecticides. The Hyman firm will continue under its present name.

The practical way to save pipes, tanks, derricks, buildings, pumps, roofs, fences

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RUST-OLEUM is the *practical, sensible* answer to your rust problems. Cuts your maintenance costs, because it may be applied *directly over rusted surfaces* after wirebrushing and scraping with sharp scrapers to remove rust scale and loose particles . . . costly sandblasting and chemical pre-cleaning are not usually required. This often enables *one man* to do the work of two with RUST-OLEUM! Practical, too . . . because RUST-OLEUM beautifies as it protects in *all colors, aluminum,* and *white.*

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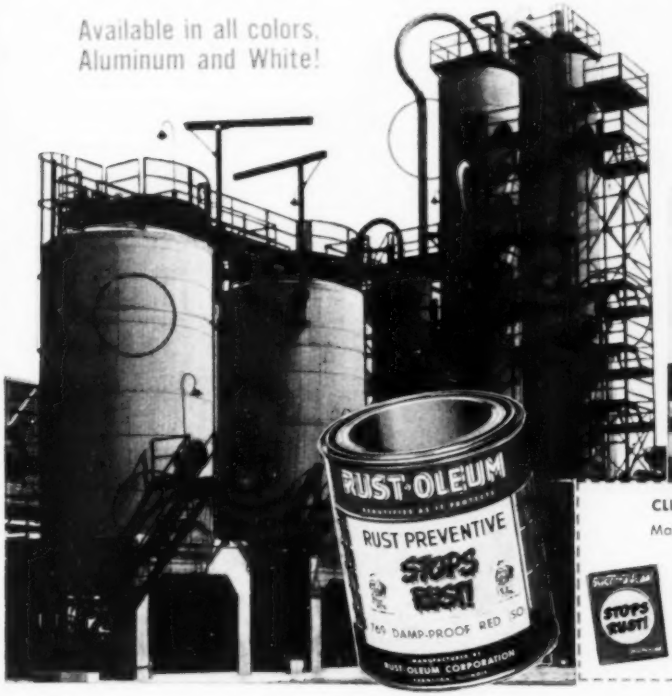

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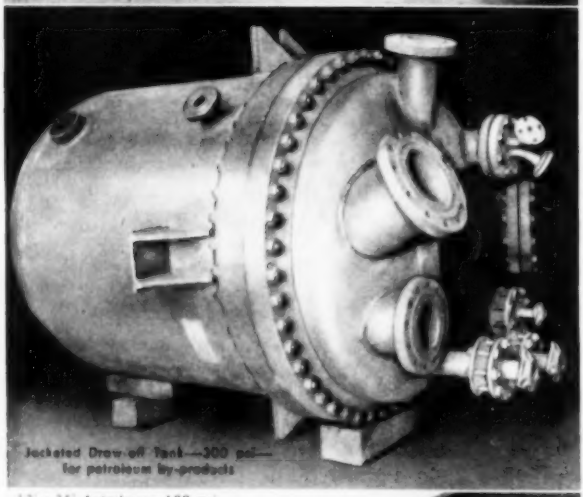
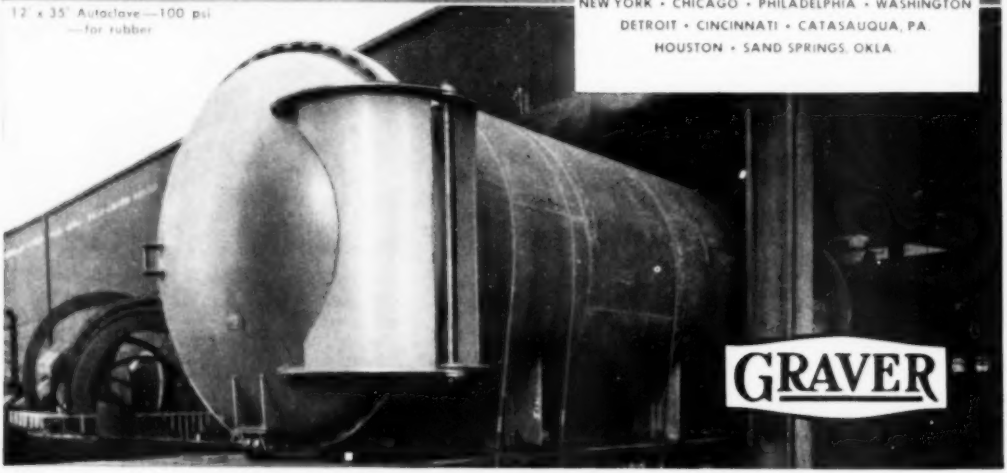
Two Quench Pots 3' x 21' 6" —33 psi— for petrochemicals



Jacketed Draw-off Tank—300 psi— for petroleum by-products

12' x 35' Autoclave—100 psi —for rubber



Processing plants today increasingly require specially designed pressure vessels. Graver has long been expert in the fabrication of code vessels, whether API-ASME, ASME or even more stringent specifications set by customers. Graver-built pressure equipment assures long life and safe, dependable service.

The steady flow of steel, clad and alloy pressure vessels through Graver's plants is suggested by these shop views. They indicate the many skills and services obtainable through Graver's high standards of welding craftsmanship.

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GRAVER

Synthetic Fuel by Hydrogenation of Coal Still a Job for "Tomorrow"

THE long-awaited study by Ebasco Services, Inc., of the Bureau of Mines' estimates of the cost of producing synthetic liquid fuels by coal hydrogenation made its appearance last month.[1]

The entire Ebasco study was restricted to seven specific points "in connection with which a difference exists between the report of the Bureau of Mines and the estimates and report commentary submitted by the National Petroleum Council." However, the studies were undertaken, at the request of the Bureau, without reference to the detailed report prepared by NPC, not made available to Ebasco.

Also, the Ebasco findings, in order to provide a common basis for comparison, were pegged at Jan. 1, 1951 figures with respect to costs, gross revenue and financial analysis. Briefly, here are the seven phases:

1—Construction cost of power plant facilities for steam and electric supply.

2—Construction cost of a plant for the purification and compression of hydrogen.

3—Analysis of operating costs, including operating labor and supplies, maintenance labor and materials, supervision, fixed, administrative, other indirect costs.

4—Analysis of the feasibility of orderly marketing for a stated volume of annual co-product chemicals and determination of gross revenue from sales.

5—Investigation of the local situation with regard to necessity for new housing facilities for construction and operating labor and as to the advisability of including provision for housing in the capital requirements of the project.

6—Evaluation of the financial program presented in the Bureau report and, if deemed necessary, recommendation of alternate or substitute programs as related to capitalization and return on investment.

7—Expression of opinion as to the methods employed by the Bureau of Mines in the preparation of the estimates, and suggestions as to effective methods for improving the presentation of projects.

In general, Ebasco was slightly below the Bureau's figures on construction costs for the two items studied (which together represent only about 25% of the total construction costs); annual operating costs were estimated to be more than 10% greater (due largely to greater labor requirements, which were more in line with NPC's estimates); annual revenue from products was estimated to be about 5% less than the Bureau figured; and no allowance in capital requirements for housing was deemed necessary, other than $250,000 for planning purposes.

The Ebasco report contains no over-all conclusions with respect to the project as a whole. But it is significant that the conclusion after a detailed study of the financial program was that "We do not believe it would be feasible to finance the projects described in the Bureau of Mines Report dated Oct. 25, 1951, with private capital under conditions prevailing at Jan. 1, 1951."

Coal hydrogenation for the production of synthetic liquid fuels still appears to be an operation for "tomorrow"—not for today. —W.F.B.

(1) "Coal Hydrogenation Plants: a Review of Certain Elements of the Bureau of Mines Cost Estimates for Synthetic Liquid Fuels." Ebasco Services Inc., March 1952 (New York).

Where Do You Plan to Locate Your New Petrochemical Plant?

ONE of the greatest barriers petrochemical manufacturers face in locating their plants is the transportation cost to get finished products to markets. They must answer the question: "Is it better to locate close to the raw materials or to the market?"

It will be noted from the map that present petrochemical plants are, in general, to be found on the "golden circle" of the Texas-Louisiana Gulf Coast, from whence their raw materials are produced, or in the East, convenient to markets. A narrow band exists between the metropolitan areas of Los Angeles and San Francisco, also. Elsewhere, development has in general been spotty.

In the future, it may be expected that this trend will change somewhat. Some chemical industry economists expect a northward trend, centering about a broad band on a curving line drawn from New York City to the Kansas-Oklahoma border and possibly extending into the Texas Panhandle (as a consequence of the Hugoton gas field). A narrow area about the Chicago and Cleveland areas may continue to develop. There is a much remoter possibility that some development may occur in the northern tier of states just east of the Rockies, perhaps restricted to supplying the needs peculiar to that area and farther West.

This "strategic band" will develop in the future, it is believed, as a compromise in location halfway between raw materials supply and consuming centers. Already the location of petrochemical plants astride gas-lines has started, represented by the Brandenburg, Ky. and Tuscola, Ill. plants. The attractiveness of refinery by-products in the Chicago area has caused at least one plant to be built there; others probably will come.

Further helping the trend is the growing adoption of oil industry techniques by the chemical industry, sparked by the "invasion" of oil companies into intermediates preparation in some cases, and growing attention to basic petrochemical raw materials. The pipeline, carrying gas products and crude oil, plus barge transportation of crude and all kinds of products, is a major factor.

More than one chemical company has evaluated the West and did not like what it saw. Raw mate-

rials are there, and potential labor, but industrialization apparently is inadequate to provide sufficiently attractive means for disposal of the inevitable by-products—materials which may provide enough added revenue to make the overall venture profitable, or else may be a waste-disposal headache. Many of these surveys are said to have indicated the best plan was to produce East of the Rockies and take the transportation rap. Shipping products East instead of West, due to transportation rate schedule construction, appears to be particularly unfavorable now, although time might alter this situation.

Consequently the chemical companies are not now sold on Horace Greeley's classical advice. They are looking for a good half-way point. —D.P.T.

Vortex Tube, Once a Lab Curio, May Have Process Possibilities

GIVE the devil his due. He may yet get on the bandwagon of new processes with a good potential in the field of hydrocarbon processing—not the main devil, but a very special one, known as the "Maxwellian Demon."

Once, many years ago, the scientist Maxwell suggested that in the realm of molecular motion it might be feasible to tap energy from a gas by using the non-uniformity of the kinetic energy or velocity of its molecules. He visualized a chamber, filled with gas, and divided into two portions by a partition. Fast and slow molecules impinge on this partition from both sides and rebound again. The over-all energy in both halves of the chamber remains unchanged as long as the distribution of slow and fast molecules remains the same.

But, if the random distribution is changed by permitting a majority of the fast molecules to accumulate in one half, while the slow ones predominate in the other; a condition is established by which energy can be drawn from the gas, utilizing the temperature gradient created by the separation of the slow and fast molecules.

To accomplish this change from random to a higher degree of order in distribution, Maxwell suggested a small gate with a doorkeeper in the partition. The doorkeeper is the "Demon." The whole idea stimulated a good deal of discussion among students of thermodynamic theory through the years.

Today, a good deal of attention is being paid to the so-called "Hilsch Vortex Tube," to which a certain analogy is apparent concerning the temperature difference created by separating fast and slow molecules. In essence, this device consists of a straight tube with a concentric orifice near one end and a nozzle permitting air to enter tangentially in the vicinity of the orifice. A throttling valve is located at the other end of the tube. With moderate pressures at the inlet to the nozzle, cold air at 100° F. below the inlet temperature is easily obtained at the orifice end of the tube, and warm air at the valve end.

This refrigeration effect, most widely publicized feature of the device, is not the only possible application for the Vortex tube. Another interesting possibility suggested lies in the separation of gas mixtures.[1] Investigations carried out along these lines are still in their initial stages. However, indications are that—in accordance with principles of thermal diffusion—the heavier molecules generally travel to the lower temperature region in the core of the tube, counteracting the forces of the centrifugal field.

One problem in the laboratory work so far—and this relates of course to that "Demon" again—is that the studies have to be carried out in sound-proofed cabinets, because of the high-pitched scream that issues from the tube when it's operating. —W.C.U.

(1) "Mysterious Hilsch Tube," A. D. Kafadar and O. E. Teetmann, the Frontier, March, 1952. Armour Research Foundation of Illinois Institute of Technology.

Tricresyl Phosphate Reduces Fouling Of Plugs in Gasoline Engines

SMALL quantities of tricresyl phosphate as an additive in both automotive and aviation gasolines has been investigated with favorable results in extending the time required for spark-plug fouling, according to a report by R. J. Greenshields, Shell Oil Co.[1] In investigating the causes for plug-fouling in automotive engines it was found that, contrary to earlier theories, deposits of lead salts resulting from the use of tetraethyl lead in the fuel were not responsible.

Extensive experimentation with laboratory and field tests, and use of special analytical tests on the deposits, indicated that metallic lead was the culprit. This material had greater electrical conductivities by several orders of magnitude than the most conductive of the lead salts. It was theorized that lead salts first deposited on the plug ceramic by incomplete scavenging. Then, during periods of idling or rich-mixture operation, and possibly during extended periods of lean-mixture operaton with incomplete combustion, carbon deposits occurred and became mixed with the lead salts.

Actual misfiring occurred when the lead salts-carbon mixture was heated during high power-output conditions (such as hill-climbing, high-speed highway driving and, in the case of airplanes, during take-off and climb) with the consequent reduction of the deposit to metallic lead. This formed an electrically-conducting path with consequent shorting of the plug or occasional mis-firing.

Since the conventional halide scavengers (ethylene dichloride and ethylene dibromide) remove most of the lead from the combustion chamber, attempts were made to find some additive which would remove the remaining lead, render it less susceptible to reduction or render the lead deposits harmless. At the same time it was important that the additive not bring with it further complications in the fuel system.

After many trials, tricresyl phosphate (TCP) was found to be outstanding. It minimized formation and deposition of metallic lead; deposits formed were phosphates of low electrical conductivity; deposits sloughed off readily and generally were soft and powdery.

From limited field-testing to date it is apparent that 0.1 to 0.2 of the theoretical TCP required to combine with the lead present in the fuel (1.5 ml. TEL) is alleviating fouling. From laboratory findings of 100% increase in spark plug life it appears the same results are being obtained in field trials of both trucks and passenger cars. —D.P.T.

(1) "Spark Plug Fouling Studies", by R. J. Greenshields, Shell Oil Co., presented before Society of Automotive Engineers, March 4-6, '52, Detroit, Mich.

Monsanto reports on corrosion-prevention test in tankers

Several months ago, the Monsanto advertisement reproduced here told you of a test of the effectiveness of Santolene C in preventing corrosion in tankers. This is a report of the results.

How test was made. Strips in two cargo compartments in a tanker were sandblasted clean. Petroleum products carried in these compartments were treated with Santolene C at the rate of 12½ 1000 bbls. Two other compartments were cleaned for comparisons. Untreated petroleum products were carried in them. One treated and one untreated test compartment always made the return trip containing salt water ballast.

How test results. After 8 months, the compartments were inspected. Sandblasted strips in tanks carrying Santolene C had slight, soft scale that could be removed by wiping. Areas not sandblasted had a dull, oily appearance. There was apparently no new scale on these areas and the scale present was clinging tightly to the sides. (This was scale that had been left on the metal when the test started.)

A hard, rust-red scale had formed on the sandblasted areas of the compartments without Santolene C. Large sheets of old scale were falling from the sides.

During the period of the test, 153,000 pounds of scale was removed from all compartments of the ship. Scale removed from the two tanks in which Santolene C treated products were carried was 50% to 60% less than that removed from the untreated compartments of the ship.

If you have a corrosion problem in carriers or in static storage of light petroleum products, consider Santolene C. For literature and technical information, write MONSANTO CHEMICAL COMPANY, 1700 South Second Street, St. Louis 4, Missouri.

Santolene, Reg. U. S. Pat. Off.

SANTOLENE C

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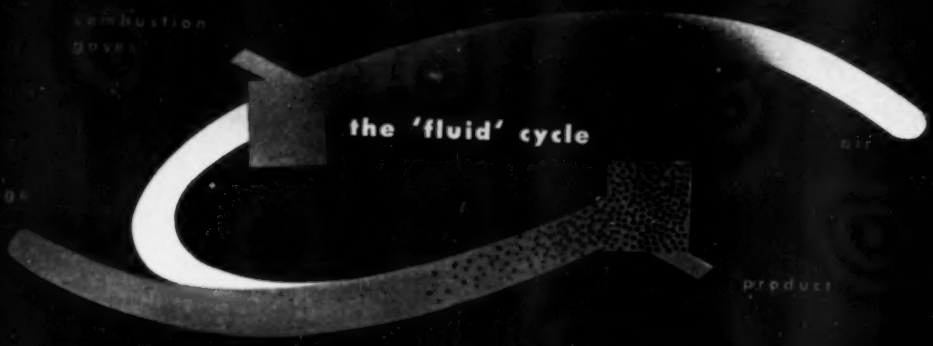
CHEMICALS – PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

(To obtain more data on advertised products see page 696)

catalytic reforming



catalytic cracking

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Flexibility in control of catalyst-oil ratios, in temperature and time functions, . . in processing charge stocks of wide variation in quality, . . plus . . continuous operation over extended periods of time . . are invaluable operating assets that add-up to one final result: the maximum production of high-octane gasoline per dollar invested.

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PETROLEUM PROCESSING

Letters

Petrochemical Processing

I have read your new "Petrochemical Processing" section with much interest, and I believe that such a section will definitely fill a need in the technical and economic literature of the chemical industry.

I think you have done a fine job in collecting the data on petrochemical plants and presenting it in concise form. I hope that you will be able to publish addenda to these tables from time to time so as to keep them up to date, and possibly also to present an annual or semi-annual summary of new construction in the petrochemical industry. This would be a most valuable feature.

I commend your courage in attempting to define the word "petrochemical." You will no doubt receive many comments on the definition which you have adopted, but, personally, I think that with one exception it is very satisfactory. Your definition starts with the words "chemical compound . . . " for the purpose, as you have pointed out, of excluding the strictly petroleum products. However, inclusion of these words in the definition would also exclude such well established products as naphthenic and cresylic acids recovered from petroleum and by-product sulfonates produced from petroleum fractions. These products clearly are petrochemicals but are normally marketed as mixtures rather than pure compounds.

It would therefore appear to be desirable to add to your definition some phrase such as ". . . or mixture of chemical compounds . . ." so as to provide for the inclusion of these materials. The exclusion of gasoline, lubricating oils, and similar petroleum products would still be satisfactorily taken care of by the final phrase ". . . and intended for chemical markets."

R. G. NEWHALL

Oronite Chemical Co.
San Francisco, Calif.

• Your definition of the term "petrochemical" is a very good one *except* for the last phrase—"and intended for chemical markets." The very examples which you cite, butane and alkylate, are "petrochemicals" in almost every sense of the word as used by others. I agree that the "normal" petroleum products should usually not be considered petrochemicals, and this includes mixed liquefied petroleum gases (although these may be cracked or oxidized as such for petrochemical production), but I certainly feel that butane is as much a petrochemical hydrocarbon as is petroleum-derived benzene. Similarly, I think you will have some trouble with this definition if such petro-

you can lose plenty if you're

UNDER-TRAPPED

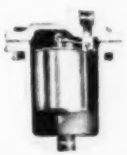
It doesn't pay to skimp on traps . . . especially steam traps. Water and air in steam lines reduces effective temperatures, wastes fuel and adds to maintenance costs.

Clark Steam Traps have proven their outstanding drainage efficiency over many years of use in thousands of plants. Now, with the new Duo-Step double-drainage capacity feature, they can handle twice the condensate of ordinary traps.

It will pay you to see your Clark representative or write us for further information.

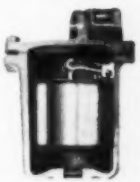
QUICK CLEANING STRAINERS. Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3" I.P.S.

SERIES "60" INVERTED BUCKET TRAP. Choice of horizontal or vertical inlet or outlet. For pressures up to 150 P.S.I. "Clark-loy" guided disc and seat.



CLARK "701" - D (DUO-STEP) TRAP. A forged steel trap for pressures up to 500 P.S.I. and temperatures of 750°F. Equipped with "double-drainage" Duo-Step leverage and venting, Clark-loy seats and discs. Pipe sizes ½" or ¾".

SERIES "80"-D (DUO-STEP) TRAPS. Cast semi-steel construction for pressures up to 250 P.S.I. and temperatures to 450°F. Equipped with Duo-Step Leverage and Venting, Clark-loy seats and discs. Pipe sizes from ½" to 2".



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TO YOUR
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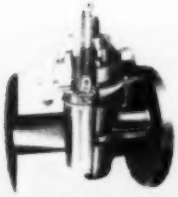
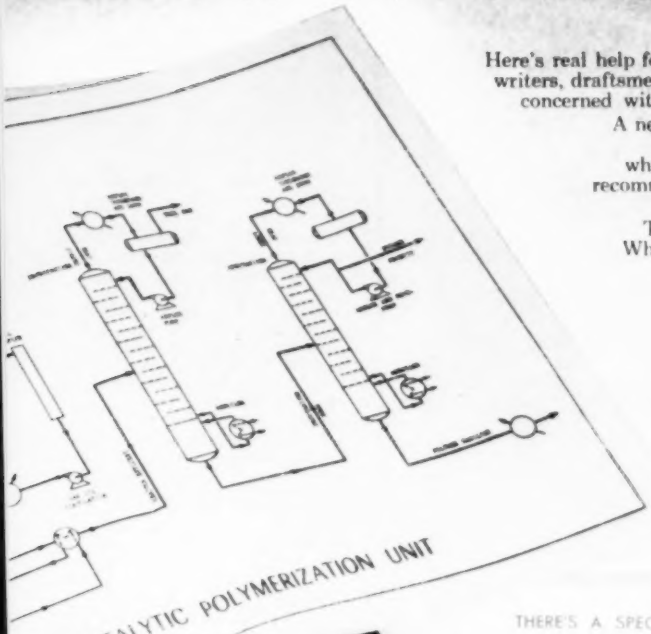


Nordstrom 2-bolt Cover Valve
(4" and smaller—Semi-Steel)

Nordstrom Valve Specifications

FOR 19 PROCESSES



Here's real help for refinery design engineers, specification writers, draftsmen, for refinery operators . . . for anyone concerned with choosing valves for refinery pipe lines.

A new Nordstrom manual "Specifications for Petroleum Refinery Services" tells you which Nordstrom valves and lubricants are recommended for each major line of flow in the most widely used refinery processes.

These specification sheets quickly answer: Which valve? Which lubricant? Size? Type? Temperature and pressure ranges? How does the valve fit into flow line? . . . every essential fact.

Ask your Nordstrom sales engineer to show you a copy. It will help you choose the *right* valve for each refinery service whether you're designing a new plant, making replacements in an old one, or building a specification list. Call your nearby Rockwell office, or write Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

THERE'S A SPECIFICATION SHEET FOR EACH OF THESE PROCESSES

- Catalytic Polymerization
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- Distillate Recovery in Cycling Plants
- Duo-Sol Solvent Extraction
- Fluid Catalytic Cracking and Gas Recovery
- Girbotol Process
- Houdriflow Catalytic Cracking and Gas Recovery
- Hydroforming Process
- Light Ends Fractionation
- Naphtha Polyforming
- Phenol Extraction
- Propane Deasphalting
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3. Average Temperature and Pressure Ranges
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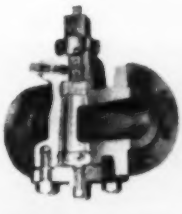
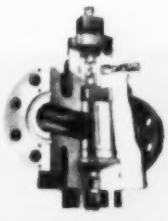
Nordstrom Standard Valve—Bolted Gland (4" and larger—Semi-Steel and Nordco Steel)



Nordstrom Hypreseal Valve (Flanged Bottom Cover)



Nordstrom Hypreseal Valve (Screwed Bottom Cover)

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- ✔ *rust preventive formulations*
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Ask Sonneborn about PETRONATE, the oil soluble petroleum sulfonate available in various molecular weights; HYPONATE, an oil free petroleum sulfonate; and PYRONATE, a water soluble petroleum sulfonate effective as an emulsion breaking reagent.

Sonneborn petroleum sulfonates—superior in quality and possessing exceptional uniformity—are now made to fit a wide variety of specific needs. They can also be tailor-made to your exact specifications. You can rely upon prompt shipment.

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White Oil, Petrolatum & Sulfonate Division

L. SONNEBORN SONS, Inc.

300 Fourth Avenue

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Achieved by Sonneborn RESEARCH

chemicals as cumene are again used as fuels instead of, as at present, as an intermediate in the synthesis of phenol and acetone. Frankly, I think that your definition would stand on its own feet without this phrase. . .

I believe you have a misprint on page 491 in which you state that the first published use of the word was in the Jan. 25, 1942 issue of the *Oil and Gas Journal*. There was no issue of that date, the closest one being Jan. 22, and it is possible that you meant to say *June* 25 . . .

B. H. WEIL
Head, Information Division
Ethyl Corp.
Detroit, Mich.

Correct; the reference should have been to the June 25, 1942 *issue of* that publication.

• I would like to call your attention to a little mistake in punctuation on page 515 ["U. S. Petrochemical Operation," April '52], where you are describing some of our products. Someone has inserted a comma between glycol and tert-dodecylthioether. This would make it appear that Sharples produces Polyethylene glycol and tert-dodecylthioether. It happens that we manufacture a product which is a nonionic surface active agent and its name is Polyethylene glycol tert-dodecylthioether.

We would appreciate it very much if in any future tabulations of this sort you would see that the comma is left out because people reading the article might approach us for the two products, which we do not make.

C. D. KARLSRUHER
Manager, Public Relations
Sharples Chemicals, Inc.
Philadelphia, Pa.

Reprints of this directory, now being prepared, will carry the correct listing for Sharples.

• . . . The material in this article ["What is a Petrochemical?"] is just what we need for our Word Files . . .

It is news to us that the earliest use of the word you have uncovered goes back to 1942 (in the form Petro-Chemistry), and we shall be much interested in the results of any further detective work you may undertake.

Also, your definition of "petrochemical" is excellent and will be utilized when the time comes for us to incorporate the word in any of our dictionaries.

Editorial Dept.
HAROLD WARD
Funk & Wagnalls Co.
New York, N. Y.

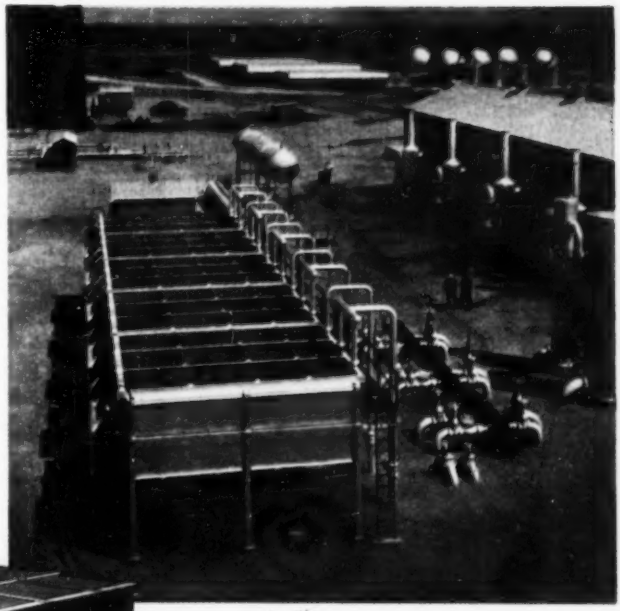
• All in all, I think your definition of "petrochemical" is quite appropriate, although I am inclined to agree with some of the gentlemen that it might be more satisfactory to say

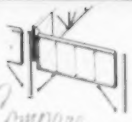
make your own comparison...

a Fluor-GR Fin-Fan

against any other air-cooled heat exchanger

When considering air-cooled heat exchanger equipment, compare the advantages of a Fluor-GR Fin-Fan. Make comparisons of structural simplicity and flexibility. Compare the exclusive features of the Griscom-Russell K-Fin section, the rugged yet precision design of Fluor mechanical equipment. Check *proven performance* in such varied services as gas transmission systems, petroleum refineries, light hydrocarbon processing plants, chemical processing plants, and power and industrial plants. Before you buy or specify, compare the Fluor-GR Fin-Fan. A Fin-Fan provides more exclusive design features—features that add up to *efficient, dependable* performance—than any other make of air-cooled heat exchanger. Write for Fluor Bulletin No. FF-4.





Compare

structural design

Structurally, the Fin-Fan is the ultimate in simplicity and flexibility. Its "truss-type" design provides a rugged, vibrationless unit, free of extraneous parts. Uniform prefabrication of parts, with bolt holes and orientation incorporated in basic design, permits easy extension without shut-down of existing units!

Compare

K-Fin features

G-R K-Fins are tension-wound for moderate temperatures, rolled into grooves for elevated temperatures. Threaded header plugs provide quick, easy access to tube ends for cleaning or replacement. Plugs are shoulder-tight to form a leakproof metal-to-metal joint at all pressures, independent of thread tightness.

FLUOR

Engineers - Constructors - Manufacturers

THE FLUOR CORPORATION, LTD., 2500 S. ATLANTIC BLVD., LOS ANGELES 22, CALIF.
New York, Chicago, Pittsburgh, Boston, Tulsa, Houston, San Francisco, Birmingham and Calgary

Represented in the Sterling area by:
Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.1., England

Compare

mechanical equipment

Fluor mechanical equipment is ruggedly designed to meet specific heat transfer requirements. 4 basic gear units cover 4 different and distinct horsepower ranges. This, coupled with a choice of fan assemblies ranging from 8' to 20' in diameter, with 4 or 6 blades per fan unit, enables the proper combination of gears and fans to effect optimum efficiency.

Compare

proven performance

More Fluor-GR Fin-Fan Air-Cooled Heat Exchangers are in service throughout the continental United States and in countries abroad than any other make. More Fluor-GR Fin-Fan installations are the result of repeat orders than any other type. Check with your nearest Fluor Representative for the Fin-Fan's outstanding record of proven performance—in services and duties similar to your own!

The Exclusive

NATIONAL AIROIL OIL-GAS TANDEM COMBUSTION UNIT

HERE'S WHY

because NATIONAL AIR OIL "Aireoeel" Tandem Units are more than just combustion equipment. They are an exclusive Combustion System which has proved many more hours "on stream" without shutdown.

"Aireoeel" Tandem Combustion Units firing dirty refinery gas; uncut asphalt, refinery fuel oils hold hot air in the combustion zone until fuel and hot air are mixed thoroughly. This means that combustion takes place in a hot zone, the result increased combustion efficiency with a minimum of excess air.

NATIONAL AIROIL Tandem Units add up to 16% further flame travel without extending the furnace front eliminating flame impingement on bridge wall and tubes, allowing longer life for these elements and because of this added flame length secondary air is controlled easily and accurately.

The Tandem Unit is popularly fired with NATIONAL AIROIL Combination Oil and Gas Burners. YOU will realize higher profits from YOUR heaters when Tandem Combustion Units are specified. Detailed literature sent upon request on your business letterhead.

CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER CO., INC.

1297 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2312 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

THIS MICRO-PRESSURE ELECTRONIC MANOMETER-FLOWMETER MEASURES

- pressure differences as small as 1/1,000,000 psi
- slightest gas flow with practically no pressure drop

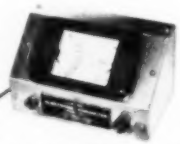
A new type manometer for critical applications and micro pressures. Highly sensitive, stable, yet lower in cost than less accurate instruments. Gauge tube can be mounted in a bypass outside pipe office, producing negligible pressure drop.

Compact low-temperature noble metal gauge tube is unaffected by high pressures. Meter sensitivity remains constant, regardless of lead length.

Dual range logarithmic type scales read directly from 0.0001" to 0.1", and 0.1" to 2" water without recalibration between ranges. Response time, less than ½ second.

This instrument can be used for master station monitoring or with a direct recording unit.

Write for descriptive literature and prices.



HASTINGS INSTRUMENT COMPANY, INC.

HAMPTON, 36, VIRGINIA

DESIGNERS AND BUILDERS OF RAYDIST AND SPECIAL ELECTRONIC, ELECTRICAL, AND MECHANICAL INSTRUMENTS

Letters

"chemicals from petroleum." However, if, as you say, the word is here to stay, we might as well have an adequate definition such as you proposed.

HENRY F. PALMER
General Manager
Kentucky Syn. Rubber Corp.
Louisville, Ky.

• . . . Your definition of the word "petrochemical" is good, and will stand unchallenged as far as I am concerned. To a practical person engaged in the business, the etymology is of little consequence. . . .

DAN M. KRAUSSE
Control Engineer
Cosden Petroleum Corp.
Big Spring, Texas

• . . . as Mr. Bland, your Engineering Editor, expected, I could argue with him regarding his definition of a "petrochemical" but I still think it is an excellent definition.

A. A. O'KELLY
Technical Director
Alox Corp.
Niagara Falls, N. Y.

• It seems to me that you have done a very fine job in attempting to identify both the word and the business; and I would not attempt to improve on your definition in any way. . . .

L. R. STRAWN
Plant Manager
Jefferson Chemical Co., Inc.
Port Neches, Texas

• . . . You have treated the subject thoroughly and most fairly. Your article will serve as a good reference when this subject comes up in the future.

MARY ALEXANDER
Universal Oil Products Co.
Chicago, Ill.

• I like your definition of "petrochemical" . . .

EUGENE AYRES
Tech. Asst. to Exec. V-Pres.
Gulf Res. and Dev. Co.
Pittsburgh, Pa.

Doesn't anyone just plain disagree with our definition?

Petrochemical Directory

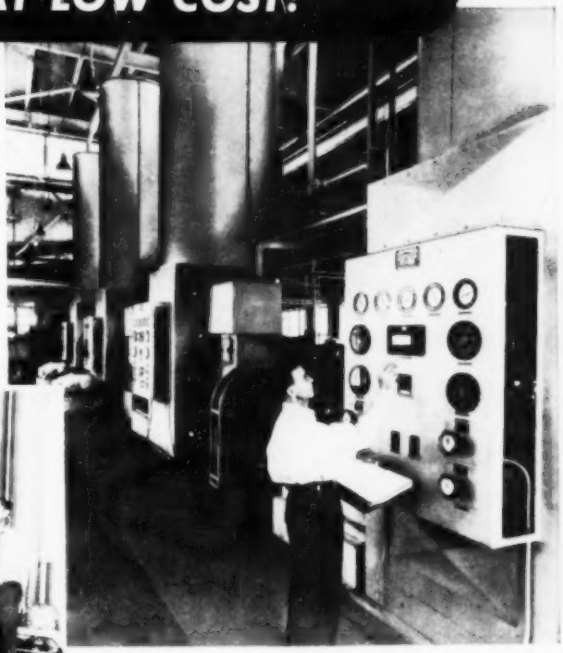
"U. S. Petrochemical Operations," a reprint from the April issue of the eight-page listing of facilities in this country for manufacture of petrochemical products may be obtained at no charge from:

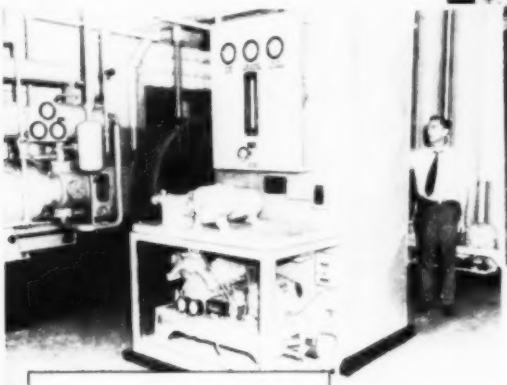
Readers Service Dept.
PETROLEUM PROCESSING
1213 West Third St.
Cleveland 13, Ohio

MAKE YOUR OWN OXYGEN and NITROGEN FROM AIR -- AT LOW COST!

Could You Use Large Quantities of Low-Cost Oxygen or Nitrogen?

If so, it will pay you to install an Air Products Generator and make your own. Numerous models are available with oxygen capacities from 200 cubic feet to 500,000 cubic feet per hour. *All of them have been proven by the acid test of operation in industry.*





ABOVE: Air Products Oxygen Generators in customer's plant. Capacity, 25,000,000 cubic feet per month.

LEFT: R-Series Air Products Oxygen Generator in customer's plant. Capacity, 500,000 cubic feet per month.

A Partial List of Users

American Chain & Cable Co., Inc.
Bethlehem Steel Co.
Thomas A. Edison, Inc.
Ford Motor Company
Granite City Steel Co.
Grede Foundries, Inc.
Hartford Hospital
Libby-Owens-Ford Glass Co.
Pettibone Mulliken Corp.
Pittsburgh Steel Foundry Corp.
Ross-Meehan Foundries
U. S. Armed Services

Noted for economy, dependability, and ease of operation, Air Products Generators employ the most advanced cycles, according to individual requirements.

Air Products, Incorporated, is a pioneer in the design and manufacture of oxygen-nitrogen generators and related equipment. A thoroughly experienced organization of over 500 people is occupied exclusively in this work. The overall background of Air Products in this field is unmatched by any other concern.

Air Products Generators have been in constant use for many years in the plants of nationally known companies. Some of these are listed at left. Air Products has effected substantial savings for all customers by eliminating the heavy costs, uncertainties and inconveniences of relying on outside sources.

We offer you experience based on the design and construction of over 400 successful oxygen-nitrogen generators.

Specialists in Equipment for All Low-Temperature Processes

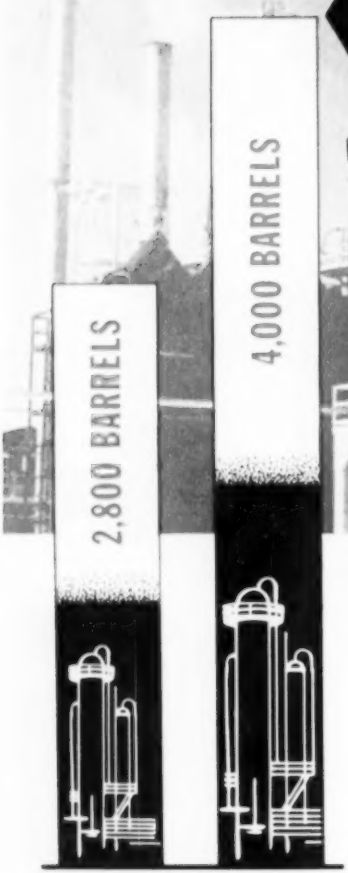
Air Products OXYGEN — NITROGEN — ARGON **Generators**

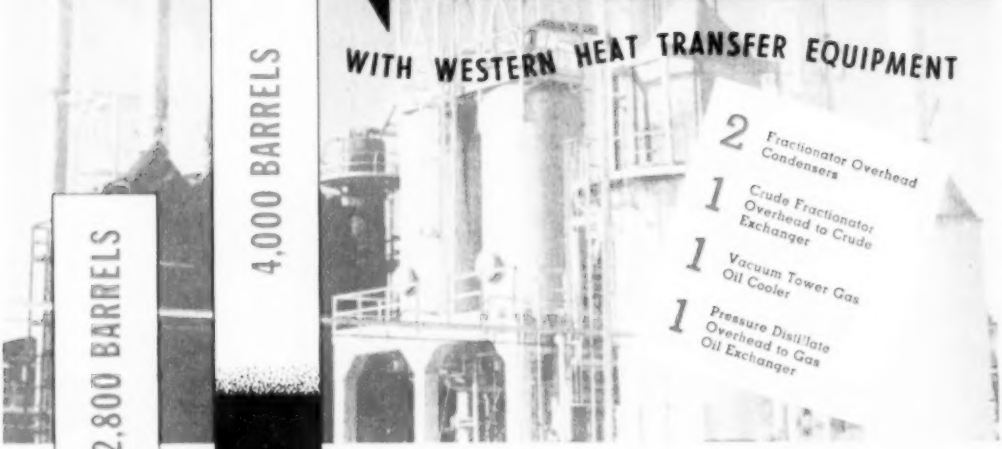
AIR PRODUCTS, Inc., Dept. L, Box 538, Allentown, Pa.

Refinery Capacity up

43% IN 43 DAYS...

WITH WESTERN HEAT TRANSFER EQUIPMENT





- 2 Fractionator Overhead Condensers
- 1 Crude Fractionator Overhead to Crude Exchanger
- 1 Vacuum Tower Gas Oil Cooler
- 1 Pressure Distillate Overhead to Gas Oil Exchanger

At the Shallow Water Refining Co., at Garden City, Kansas . . . an unparalleled opportunity for plant enlargement arose. A rapid increase in available crude from the immediate area made it possible to jump the throughput of the plant 43% in a matter of weeks! Shallow Water had both the tower and furnace capacity, but heat transfer installations wouldn't handle the additional load. A rush call to Western Supply Company . . . an explanation of the "now or never" situation . . . and 43 days later the critical heat exchangers were on their way to Kansas. Is it any wonder that from coast to coast, refinery, pipeline and field processing men "Look to Western" for heat transfer service.

TEMA

WESTERN
HEAT EXCHANGERS

Manufactured by
WESTERN SUPPLY COMPANY
P.O. BOX 1888 TULSA, OKLAHOMA

REPRESENTATIVES:

TRIDENT ENGINEERING CO.
San Francisco, California

JACKSON ENGINEERING CO.
Los Angeles, California

ARTHUR B. ANDERSON CO.
Minneapolis, Minnesota

(To obtain more data on advertised products see page 606)

Hooker Chemical Guide
(ONE OF A SERIES)
USE this handy reference to save time in selecting high quality chemicals.

HOOKER SULFIDES

SODIUM SULFIDE

Formula: Na_2S

Appearance: Light, buff colored solid in flake form

TYPICAL PROPERTIES

Molecular Weight	78.1
Melting Point	100° C
Na_2S	60-62%
Water of Crystallization	35% min.
NaCl	1.5% max.
Other Na Salts	2.0% max.
Fe	8 ppm max.
Other Heavy Metals	1 ppm max.

USES

Dehairing Agent: Hides

Desulfurizing Agent: Viscose rayon

Intermediate: Chemicals, dyestuff intermediates

Metal Processing: Ore flotation, metal refining

Other Uses: Manufacturing paper pulp, rubber; textile processing.

SODIUM SULFHYDRATE

Synonym: Sodium Hydrosulfide

Formula: NaSH

Appearance: Light lemon colored solid in flake form

TYPICAL PROPERTIES

Molecular Weight	56.1
Melting Point	55° C
NaHS	70 to 72%
Water of Crystallization	26% min.
Na_2S	2.5% max.
Other Na Salts	1.2% max.
Fe	5 ppm max.
Other Heavy Metals	1 ppm max.

USES

Dehairing Agent: Hides

Desulfurizing Agent: Viscose rayon

Intermediates: Dyestuffs; organic chemicals such as thioamides, thiourea, thioglycolic acid, thio- and dithiobenzoic acids, sodium thiosulfate.

SODIUM TETRASULFIDE SOLUTION

Formula: Na_2S_4

Appearance: Clear, dark red aqueous solution

TYPICAL PROPERTIES

Molecular Weight	174.2
Freezing Range	3.5° to −17° C
Distillation Range	115° to 120° C
Specific Gravity, 15.5°/15.5° C	1.335
Na_2S_4	40%
Sulfur	30%

USES

Soaking Agent: Hides and skins prior to unhairing

Reducing Agent: For organic nitro bodies

Reagent: Ore flotation

Intermediate: Sulfur dyes

For detailed information on items listed, drop us a note on your letterhead. Address your request to HOOKER ELECTROCHEMICAL COMPANY, 4713 Buffalo Ave., Niagara Falls, N. Y.

HOOKER ELECTROCHEMICAL COMPANY

NIAGARA FALLS, N. Y. • TACOMA, WASH. • WILMINGTON, CALIF.

HOOKER CHEMICALS

2-325

From the Salt of the Earth

puts the HEAT on heat exchangers

By changing to Yarway Impulse Steam Traps, an oil refinery reports much hotter steam in their heat exchangers **—plus two other important extras:**

(1) They were able to operate the plant with 6 boilers instead of the 8 formerly required.

(2) Three men formerly required to service old-type traps can now be used for productive work.

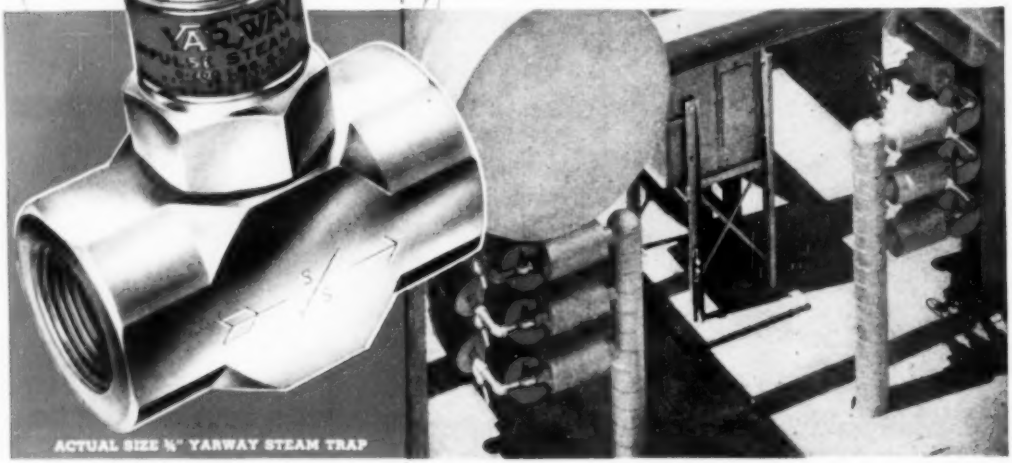
Significant sidelight—these Yarway traps are operating under severe conditions, many outdoors with temperatures often below zero.

Plant after plant is standardizing on Yarway Impulse Steam Traps because Yarways are designed to deliver the most premium B.T.U.'s at top temperatures into your process or product. **They get equipment hotter, sooner . . . and keep it hot.**

Other reasons—small size, easy installation, good for all pressures, only one moving part, low maintenance, low price.

Buy your Yarway Impulse Steam Traps from one of the 216 distributors handling this product.

YARNALL-WARING COMPANY
153 Mermaid Ave., Philadelphia 18, Pa.



ACTUAL SIZE ½" YARWAY STEAM TRAP

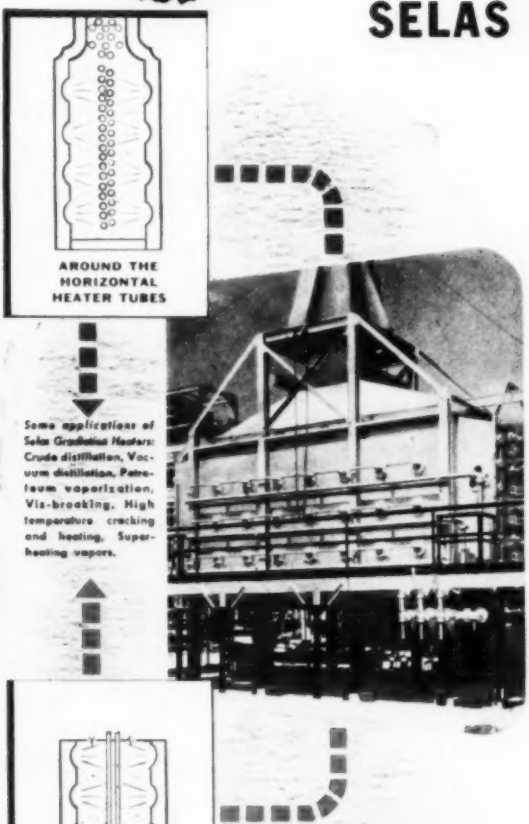
FREE OFFER. Don't take our word for it. Test Yarway's advantages in your own plant, without cost or obligation. Drop us a card or letter—a trial trap will be delivered promptly.

YARWAY the steam trap
designed with more production in mind

(For additional data on advertised products see page 696)

FASTER.. UNIFORM.. PROCESS HEATING IS IMPROVING YIELD QUANTITY.. QUALITY

SELAS *Gradiation*® HEATERS


AROUND THE HORIZONTAL HEATER TUBES
Some applications of Selas Gradiation Heaters: Crude distillation, Vacuum distillation, Petroleum vaporization, Vis-breaking, High temperature cracking and heating, Superheating vapors.
ALONG THE HORIZONTAL HEATER TUBES

Radiant petroleum heaters—*Selas Gradiation Heaters*—processing the same catalytic cycle oil as conventional box furnaces, are yielding 40 per cent more gasoline and increasing the octane rating four to six points.

Major refiners have approved and applied Selas Gradiation Heater designs to obtain these and similar results, specifying heat rates that are far over the standards based upon operating experiences gained from conventional heaters.

The design principle of the SELAS GRADIATION HEATER is based upon:

1. Direct, controlled radiant heat distribution around and along the horizontal heater tubes.
2. Complete combustion, with little or no excess air.

The design of the Selas Heater provides:

1. High and uniform rates of heat transfer,
2. Positive rate-control of oil heating,
3. Low time-temperature charge residence, if that is a desirable processing factor,
4. Factory prefabrication, with as little as eight hours required for erection on sites,
5. Excellent fuel economy.

Uniform intensity of radiant heat is directed to all tube surfaces from the radiant burners. Flexibility is attained by sectional variation and control of the heating rate.

A completely descriptive Bulletin and other authoritative technical description are available upon request.

SELAS CORPORATION OF AMERICA
PHILADELPHIA 34, PENNSYLVANIA

Heat Processing Engineers for Industry · Development · Design · Manufacture

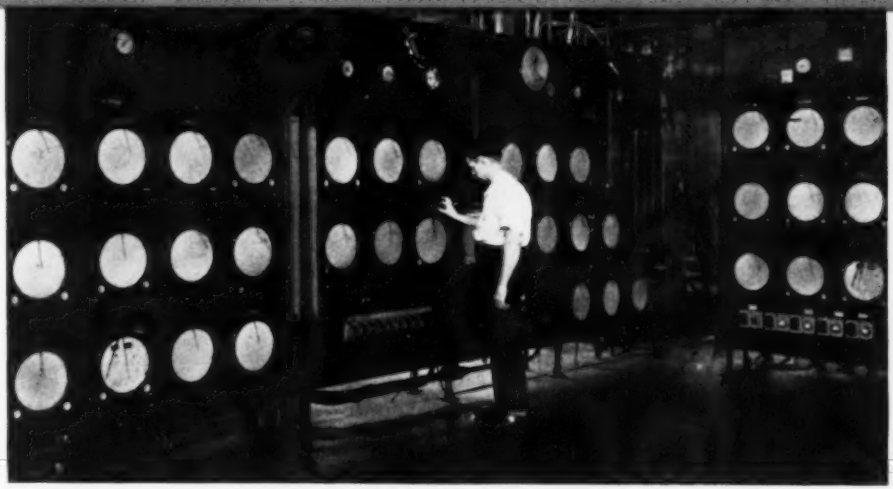
Building

Processing Units and (at right) Brown Control Panelboard for Plexiglas production at Rohm & Haas Company, Bristol, Pa.

BROWN INSTRUMENTATION

. . . is patterned to the exact requirements of individual plants and processes . . . is the result of engineering and application know-how, with one responsibility from sensing elements to control valves . . . is backed by a nationwide field engineering and service organization.

new molecules . . .



with the help of
Brown Advanced Instrumentation

TODAY'S tremendously increased demand for synthetic resins and rubbers is being met by greatly accelerated production of vinyl type and other polymers. Keeping pace with this gigantic effort is the production of Plexiglas at the modern Rohm & Haas plant at Bristol, Pa.

Control of every significant step in this polymerization process is synchronized by efficient, coordinated Brown Instrumentation. From a centrally located panelboard, these instruments insure precise regulation of even the most complex exothermic reactions, where process variables must stay within stringent limits.

When choosing recording and controlling instruments for your vinyl polymerization process, or *any* polymerization process, consider first:

- *Brown Creative Instrumentation—the know-how developed through many years of application experience in the industry.*
- *The completeness of Brown equipment—encompassing sensing elements, recorders, controllers, panelboards (both conventional and graphic), valves and accessories.*

For a detailed discussion of control requirements of your process, call in our local engineering representative . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4582 Wayne Avenue, Philadelphia 44, Penna.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

- *Important Reference Data*
  Write today for Composite Catalog 5000.

WeldELLS

...have set their own standards

Many of the largest users of Welding fittings refuse to accept any other fittings than WeldELLS.

They have found that when the name, WeldELL, is stamped into a fitting, that fitting can be accepted without question for any service for which it is designed.

They have found that WeldELLS have features that please both the men who design and the men who erect welded piping . . . features that were pioneered by Taylor Forge . . . features that are combined in no other welding fittings.

They have found the answer to their every need in the greater range of sizes, weights and types of the WeldELL line . . . in the broader scope of materials.

Ask for up-to-the-minute facts about WeldELLS and Taylor Forged Steel Flanges.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS, General Offices and Works: P.O. Box 485, Chicago 90, Ill.
Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

A gearturbine built to save...

Three ways

The Westinghouse Gearturbine costs less to buy . . . less to install . . . and less to maintain. Wrapped up in a single package is a compact, rugged and reliable speed-reduction unit solidly coupled to a Type E turbine. It's the ideal combination for ratings up to 500 hp and output speeds commonly found in single-ended applications.

Here's economy made possible by a standardized design that cuts manufacturing costs . . . avoids costly specials . . . saves space . . . and simplifies maintenance. And you get the maximum flexibility possible . . . any combination of three turbine wheel sizes, three gears and three types of governor can be used according to your needs.

Other plus features are . . . solid coupling of turbine shaft to pinion shaft; single-helical gearing; forced circulation, filtered oil; and 3-point support for easy mounting and leveling.

J-50521

GET THE FULL STORY. A newly available booklet, B-4346, clearly explains the applications, refinements and advantages of Westinghouse Gearturbines. Ask your nearby Westinghouse representative for your copy, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

YOU CAN BE SURE.. IF IT'S
Westinghouse

Turbines

...today's dollar and tomorrow's returns

Here at Lummus we hold a deep respect for our customers' 1952 dollar and 1957 returns. *This* has a meaning all its own to responsible management with capital to commit for petroleum, petroleum chemical and chemical plants.

You'll find these price and value factors well taken care of in every project designed, engineered and constructed by Lummus. On each job, *process improvement* is the paramount goal—achieved by applying every technological advancement and modern design. Thus we won't compromise, no matter how great the demand may be for immediate new production facilities.

What's more, the plants must have the flexibility to answer needs of the future. Engineering ingenuity at Lummus concerns itself with taking every precaution today against a future time when outmoded tools may put you at a competitive disadvantage.

That sums up our interpretation of judicious spending. Over six hundred soundly-designed, profit producing plants have been built on this steadfast concept. You may wish to bear these facts in mind on *your* next project.

THE LUMMUS COMPANY

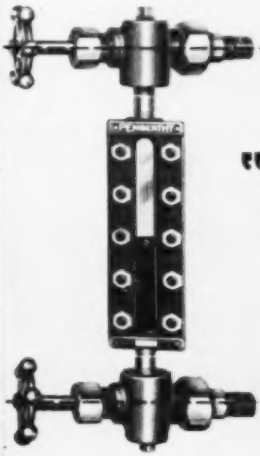
385 MADISON AVENUE, NEW YORK 17, N. Y.

HOUSTON • CHICAGO • LONDON • PARIS • CARACAS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

(To obtain more data on advertised products see page 696)

Penberthy Reflex Gage



Penberthy Transparent Gage

PENBERTHY "FLOATING SHANK"

Permits 3/8" Variation in Center-to-Center of Vessel Tapping

Patent Applied for

COMPENSATES FOR VESSEL TAPPING INACCURACIES

•

SAVES INSTALLATION TIME

•

REDUCES GAGE STRESSES

Another **PENBERTHY** *First*

An important new feature now available on all Penberthy drop forged steel gage valves is the "floating shank" . . . an improvement that has money-saving advantages to many users of liquid level and water gages.

The "floating shank" compensates for inaccuracies in the center-to-center distance of the tapped holes in the vessel on which the gage is mounted. The variation can be as much as 3/8". It provides a mounting flexibility not elsewhere obtainable . . . it saves time during installation of the gage . . . it eliminates stresses that are often induced during mounting.

The Penberthy "Floating Shank" can be had at slight additional cost . . . specify it on your next order for Penberthy drop forged steel (or alloy) gage valves.

PENBERTHY INJECTOR COMPANY

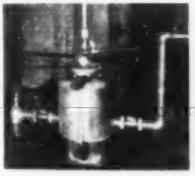
DIVISION OF THE BUFFALO-ECLIPSE CORPORATION

Detroit 2, Michigan

Established 1886 — *Canadian Plant, Windsor, Ontario*

OTHER PENBERTHY PRODUCTS

PENBERTHY CYCLING JET PUMPS



Automatically operated by air, gas or steam pressure . . . Will pump without clogging any liquid that will flow through pipes. Ask for Bulletin 5030.

PENBERTHY EXPLOSION-PROOF SUMP PUMPS

Motor and switch totally enclosed. Underwriter approved for Class I, Group D, and Class 2, Groups E, F and G hazardous location. Made of copper and bronze throughout. Ask for Bulletin 4929.

PENBERTHY EJECTORS

A simple jet pump operated by air, water or steam. Needs no lubrication . . . will not get out of order. Ask for Bulletin 5080.

PENETRATES---

cracks...joints...rivet holes

TO PROTECT METAL 4 WAYS

Rust and corrosion find weak spots in a priming film *fast*, in petroleum service.

That's why KROMIK® has proved such an outstanding, standard priming material, not only in the petroleum industry, but in railway, marine and structural steel service, for year after year after year.

KROMIK outperforms single-pigment primers because, for one reason, it is formulated to *penetrate* into joints and rivet holes . . . to cover evenly, whether brushed or sprayed, avoiding the weak spots that occur with heavy-pigmentation primers that leave "valleys" when brushed. KROMIK dries through, forming a tough, tight film that withstands weather and abrasion . . . lends itself well to application of aluminum paint and either dark or light-colored finishing coats.

Ask for proof. Check your Sherwin-Williams representative or write The Sherwin-Williams Co., 101 Prospect Avenue, Cleveland 1, Ohio.

KROMIK

the 4-pigment primer

1 PREVENTS RUST

KROMIK incorporates the best protective properties of *red lead* to resist moisture —stop rust before it starts.

2 INHIBITS CORROSION

Zinc chromate—another protective pigment —adds extra resistance against corrosion.

3 RESISTS ABRASION

Zinc oxide aids drying and hardness— makes KROMIK equal to most top coats in toughness and resistance to abrasion.

4 WITHSTANDS WEATHER

Iron oxide enables KROMIK to withstand sun and weather even if exposed for long periods before top coats are applied.

SHERWIN-WILLIAMS

PETROLEUM FINISHES

TORTURE CHAMBER

for VALVE and FITTING MATERIALS

Here, steam up to 1500 pounds pressure and 1000° F. gives Vogt the answer to any question of materials or construction for valves and fittings in just a few days . . . facts that would take years to obtain under normal operating conditions!

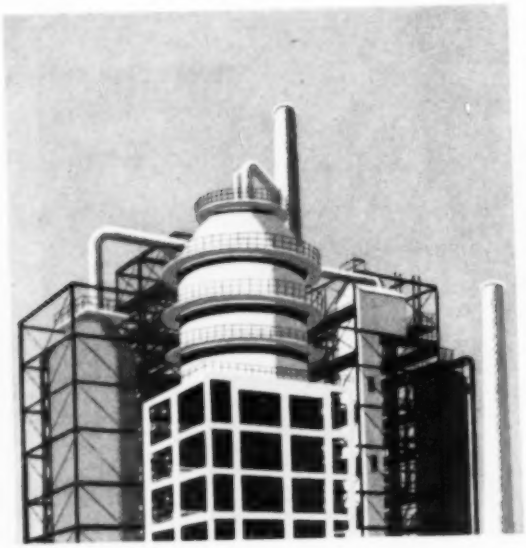
We set up our own Torture Chamber to determine the durability of valve packings and gaskets; the resistance of various steels to corrosion and erosion; and how hard and how smooth surfaces of seats, discs and stems must be to withstand steam at high pressures and high temperatures. We tested and found an ideal yoke nut material, and we uncovered facts on joint design that could be found in no other way.

Thus, by constant and accelerated testing, we quickly and definitely prove or disprove the claims that are made for many newly developed materials. And thereby we make sure that only the best goes into valves and fittings that bear the name Vogt.

Consult Catalog F-9 for the complete Vogt line of drop forged steel valves, fittings and flanges for steam, water, oil, gas, air and refrigeration services.

HENRY VOGT MACHINE CO., Louisville 10, Ky.

BRANCH OFFICES: NEW YORK • CHICAGO • CLEVELAND
PHILADELPHIA • ST. LOUIS • DALLAS • CHARLESTON, W. VA.



Top Performance from Cat-Cracker Regenerators

A CAREFUL STUDY OF THE REGENERATION DATA FROM CATALYTIC CRACKING INDICATES THAT OXYGEN DISAPPEARANCE (USUALLY CALLED HYDROGEN IN COKE) INCREASES WITH INCREASING CARBON ON REGENERATED CATALYST. ABILITY TO CRACK GAS OIL, AS WELL AS GIVE GOOD GASOLINE TO CARBON RATIOS, DROPS RAPIDLY WITH INCREASING CARBON ON REGENERATED CATALYST; HENCE THE CATALYST THAT REGENERATES MOST EASILY CAN SHOW REAL ADVANTAGES. BY ITS NATURE, FILTROL'S CATALYST FLUID 58 HAS A FASTER REGENERATION RATE IN COMMERCIAL OPERATION THAN OTHER CATALYSTS IN GENERAL USE. THE BETTER REGENERATION RATE RESULTS IN BETTER OXYGEN UTILIZATION, HIGHER GASOLINE CARBON RATIOS AND GREATER RETURN FROM CAT CRACKING OPERATIONS.

ORSAT ANALYSIS	FILTROL CATALYST FLUID 58	OTHER CATALYSTS
%CO:	11.8	9.5
%CO	5.7	7.3
%O₂	1.7	2.5
CARBON BURNED, # HR.	18,500	17,900
HYDROGEN IN COKE	8.4	9.6
CARBON ON REGEN. CAT.	0.3	0.6

} 1.31

THE FIGURES SHOW THAT CO₂ CO RATIO IS NOT THE CRITERION OF REGENERATION CAPACITY.

OTHER REASONS FOR USING FILTROL CATALYSTS

1. Higher octane barrels
2. High butylene yield
3. Low cost
4. Sulphur resistant catalysts
5. Technical assistance
6. Varied plant facilities
7. Uniformity
8. Lowered excess butane
9. Low attrition rate

Filtrol*

FILTROL CORPORATION

OFFICES: 727 WEST SEVENTH ST., LOS ANGELES 17, CALIFORNIA
PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

CATALYSTS AND ADSORBENTS

* REG. U.S. PAT. OFF.

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DEPENDABLE Service

40 years of practical experience are behind Continental engineers and service specialists in every phase of the industry. You can count on their recommendations being sound and helpful.

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Representatives: ARGENTINA • BOLIVIA • BRAZIL • CHILE • COLOMBIA • ECUADOR • PERU • TRINIDAD • URUGUAY • VENEZUELA

Experienced

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Diversified

ENJAY

*Trade Mark

offers an extensive line of oxygenated solvents and chemicals...

ENJAY markets this wide range of industrial chemicals:

Petrohol 91 (Isopropyl Alcohol)
Petrohol 95 (Isopropyl Alcohol)
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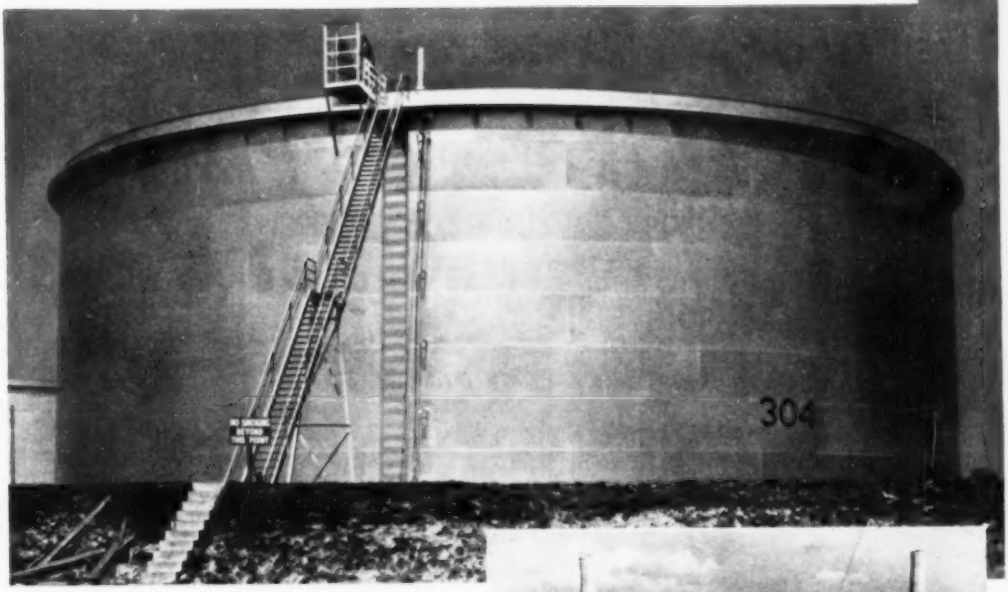
Ethyl Ether
Isopropyl Ether
Diisobutylene
Polypropylenes
Butadiene
Isoprene
Dicyclopentadiene
Aromatic Tars
Paratone
Parapaid
Paratac
Paranox
Paraflow
Vistanex
Naphthenic Acids

The solvents and chemicals sold under the ENJAY* Oval Trade-Mark are outstanding for high quality and dependability. Every day more industries are calling on the long experience of the Enjay Company . . . making greater use of the diversified line of solvents and chemicals marketed by Enjay to increase product quality.

ENJAY products are marketed in bulk or in quantities to fit your requirements.

ENJAY COMPANY, INC., 15 West 51st St., New York 19, N. Y.

GREAT BRITAIN'S "*ACE IN THE HOLE*"

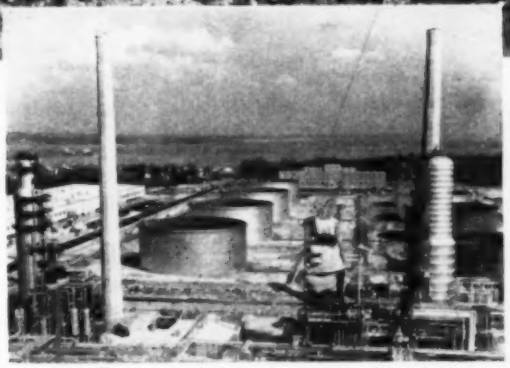


Horton Tanks Serve Giant Refinery at Fawley

Faced with the loss of Abadan, the world's largest oil refinery, Great Britain still has this *ace in the hole* at Fawley, England. It's the Esso Petroleum Company's giant 100-million dollar refinery which went on stream in September. In its first year, Fawley is expected to produce 5.5 million tons of gasoline, bunker fuel, jet fuel, naphtha, asphalt, lubricating oils, and kerosene. That's more than twice the amount of refined products imported from Iran.

Playing an important part in the successful operation of this huge refinery are thirteen 110-ft. diam. by 54-ft. tanks equipped with Horton Pontoon Floating Roofs. They were built in England by Whessoe Limited, a Chicago Bridge and Iron Company licensee.

Horton *Pontoon* Floating Roofs ride directly on the liquids stored in tanks. By eliminating the air vapor space, they eliminate breathing and filling evaporation losses, cut down on corrosion and reduce the danger of fire in the storage area.



The view above illustrates a portion of the giant Esso Petroleum Company refinery at Fawley.

For more information on Horton Floating Roofs or any other Horton structure, write our nearest office. There is no obligation on your part.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, and GREENVILLE, PENNSYLVANIA

Atlanta 3	2103 Healey Building	Detroit 26	1532 Lafayette Building	Philadelphia 3	1630–1700 Walnut St. Building
Birmingham 1	1527 North Fiftieth Street	Havana	402 Abreu Building	San Francisco 4	1559–200 Bush Street
Boston 10	1029–201 Devonshire Street	Houston 2	2130 C&I Life Building	Seattle 1	1330 Henry Building
Chicago 4	2114 McCormick Building	Los Angeles 17	1526 General Petroleum Building	Tulsa 3	1620 Hunt Building
Cleveland 15	2215 Guildhall Building	New York 6	3310–165 Broadway Building	Washington 6, D. C.	1135 Cafritz Building

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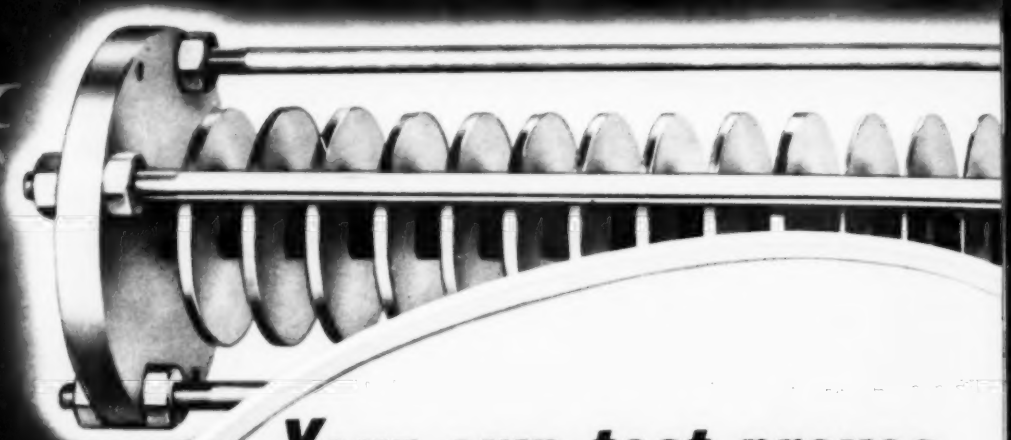


Your own test proves

AMPCO*

ALUMINUM BRONZES

Typical Applications in which Ampco Alloys have been used with Cost-Saving Success!

Absorption columns
Acetylators
Acid chain
Agitators
Autoclaves
Baskets
Bearings
Beater bars
Bellows
Bolts and nuts
Brazing rod
Brine coils
Bubble caps and trays
Calandrias
Condenser shells
Condenser tubes
Condenser tube sheets
Control valves
Conveyors
Coolers
Crystallizers
Dephlegmators
Digesters
Ejectors
Evaporators
Evaporator tubes
Extractors
Fabricated assemblies
Filters and filter screens
Filter presses
Fittings — forged, cast
Forgings
Fractionating columns
Hangers
Heat exchangers
Heater coils
Hooks
Injectors
Instrument cases and elements
Kettles
Line hardware
Meter cases
Mixers
Pans, evaporator
Perforated plate
Pickling baskets
Pipe and fittings
Plug cocks
Pressure vessels
Pumps
Reboilers
Retorts
Rivets
Safety tools
Screens
Screws, conveyor
Sludge burners
Springs
Stills
Studs
Sucker rod
Tanks
Tools, safety
Towers
Trays, fractionating
Tubes and tubing
Vats
Valves
Welding rod
Wall tubing
Wire
Woven wire cloth

Chemical Agents and the Applicability of AMPCO Alloys

Acetate Solvents (Pure)	E
Crude	G
Acetic Acid	
Crude	E
Vapors	E
Acetic Anhydride	G
Acetone	E
Acetylene	NR
Alcohols	E
Aluminum Fluoride	G
Aluminum Sulfate	G
Aluminum Hydroxide	E
Ammonia Gas	
Dry	G
Wet	NR
Ammonium Chloride	NR
Ammonium Hydroxide	NR
Ammonium Nitrate	F
Ammonium Phosphate	F
Ammonium Sulfate	F
Amyl Chloride	E
Asphalt	E
Barium Chloride	G
Beer	E
Beet Sugar Liquors	E
Benzene or Benzol	E
Borax	E
Boric Acid	E
Brine	E
Butane Butylene	E
Butadiene	E
Butyric Acid	E
Calcium Bisulfite	G
Calcium Hydroxide	G
Calcium Hypochlorite	F
Cane Sugar Liquors	E
Carbolic Acid	E
Carbon Dioxide	
Dry	E
Wet	G
Carbon Disulfide	E
Carbon Tetrachloride	E
Caustic Soda	E
Chlorine	
Dry	G
Wet	NR
Chloroform	E
Chromic Acid	NR
Citric Acid	E
Copper Sulfate	NR
Crude Oils — Sour	G
Esters	E
Ethers	E
Ethylene Glycol	E
Ethyl Sulfate	E
Ferric Chloride	NR
Ferric Sulfate	NR
Formaldehyde	E
Formic Acid	E
Freon	E
Furfural	E
Gasoline	E
Gelatine	E
Glucose	E
Glycerine	E
Hydrocarbon Gases	E
Hydrochloric Acid	
to 5%	G
to 10%	F
(see Muriatic)	
Hydrocyanic Acid	NR
Hydrofluoric Acid	G
Hydrogen Fluoride (Dry)	E
Hydrogen	E
Hydrogen Peroxide	F
Hydrogen Sulfide	
Wet	NR
Dry	F
Lacquers and Lacquer Solvents	E
Lactic Acid	E
Magnesium Chloride	G
Magnesium Hydroxide	F
Magnesium Sulfate	E
Malt Beverages	E
Mercuric Chloride	NR
Mine Water (Sulfate)	E
Molasses	E
Monochlorobenzene	E
Muriatic — Cold, Commercial	G
Naptha	E
Natural Gas	E
Nickel Chloride	F
Nickel Sulfate	G
Nitric Acid	NR
Nitrogen (Dry)	E
Oleic Acid	E
Oxygen	E
Paint Vehicles (Except Soya-Oil)	G
Palmitic Acid	E
Petroleum Oils	
Sour	G
Refined	G
Phenol	E
Phosphoric Acid	E
Pickling Acid (except Nitric Chromic)	E
Potassium Chloride	E
Potassium Cyanide	NR
Potassium Hydroxide	F
Potassium Sulfate	E
Potash Crudes	E
Propane	E
Shellac	E
Soaps	E
Soda Ash (Sodium Carbonate)	G
Sodium Bicarbonate	E
Sodium Bisulfate	E
Sodium Carbonate	E
Sodium Chloride	E
Sodium Cyanide	NR
Sodium Hydroxide	E
Sodium Nitrate	G
Sodium Perborate	E
Sodium Peroxide	F
Sodium Phosphate	
Alkaline	E
Neutral	G
Acid	E
Sodium Silicate	E
Sodium Sulfate	
(Soda Cake)	E
Sodium Sulfide	NR
Sulfur	F
Sulfur Chloride	NR
Sulfur Dioxide	
Dry	G
Wet	G
Sulfuric Acid	
5%	E
10%	E
25% Up to Boiling	E
35%	E
50%	E
Sulfuric Acid Sludge	G
Sulfurous Acid	G
Tannic Acid	E
Tartaric Acid	E
Toluene or Toluol	E
Tri Chlorethylene	E
Tri Sodium Phosphate	E
Turpentine	E
Varnish	E
Vegetable Oils	E
Water	
Fresh	E
Salt (includes Polluted Harbor)	E
Xylene	E
Zinc Chloride	G
Zinc Sulfate	E

These ratings may usually be interpreted as follows:

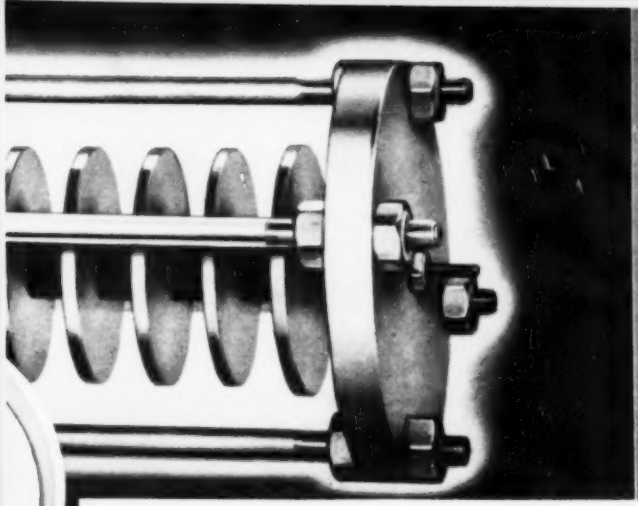
E — Excellent
IPY Penetration
.< 0.004"

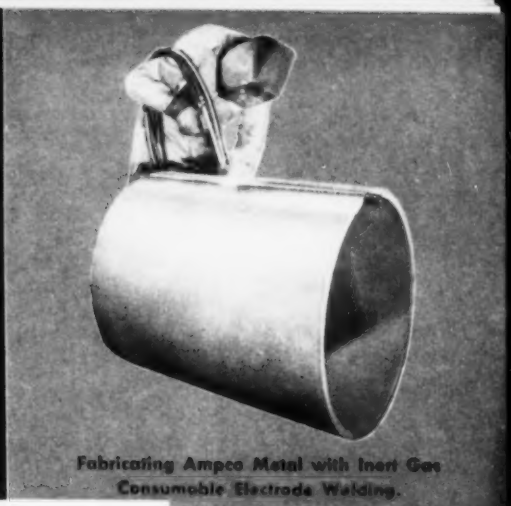
G — Good
IPY Penetration
.< 0.016"

F — Fair
IPY Penetration
.< 0.250"

NR — Not Recommended
IPY Penetration
Over 0.050"

In using this data, it should be understood that these are results of specific tests and are indicative of those conditions under which the tests were run, and are a basis for recommendation, but not for guarantee.





Fabricating Ampco Metal with Inert Gas Consumable Electrode Welding.

are a Practical Remedy for Your Corrosion Ailments

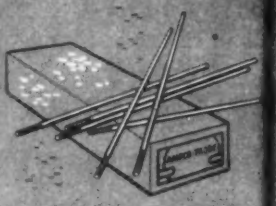
The success of Ampco aluminum bronzes in solving many different corrosion problems for a wide variety of applications is quickly evident from a glance at the tables on the opposite page.

But you may have a special problem of your own. You may want to make your own tests — prove to yourself that Ampco aluminum bronzes offer a money-saving solution.

Here's all you have to do: We have a complete stock of test specimens of different materials which can be mounted on racks. Several forms of racks are available for tests in atmospheric locations, pipe lines, tanks or other pressure vessels. Just write and ask for test specimens, but be sure to outline the conditions under which the test is to be conducted so that we can supply the most suitable form.

Here's another service that can help you. Sometimes repeated 60- to 90-day exposures are required. Our own technicians will work with you through the testing period, pilot plant and preplant operations. Write today.

Ampco Plug Valves



Ampco Bronze Electrodes

Ampco Pipe Fittings

*Reg. U. S. Pat. Off.

Tear out this coupon and mail today!

Ampco Metal, Inc.
Milwaukee 46, Wisconsin
West Coast Plant, Burbank, California

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AMPCO METAL, INC., Dept. PP-5, Milwaukee 46, Wisconsin

Send me information on the application of Ampco Aluminum Bronzes for corrosion-resistant service in the Process Industries.

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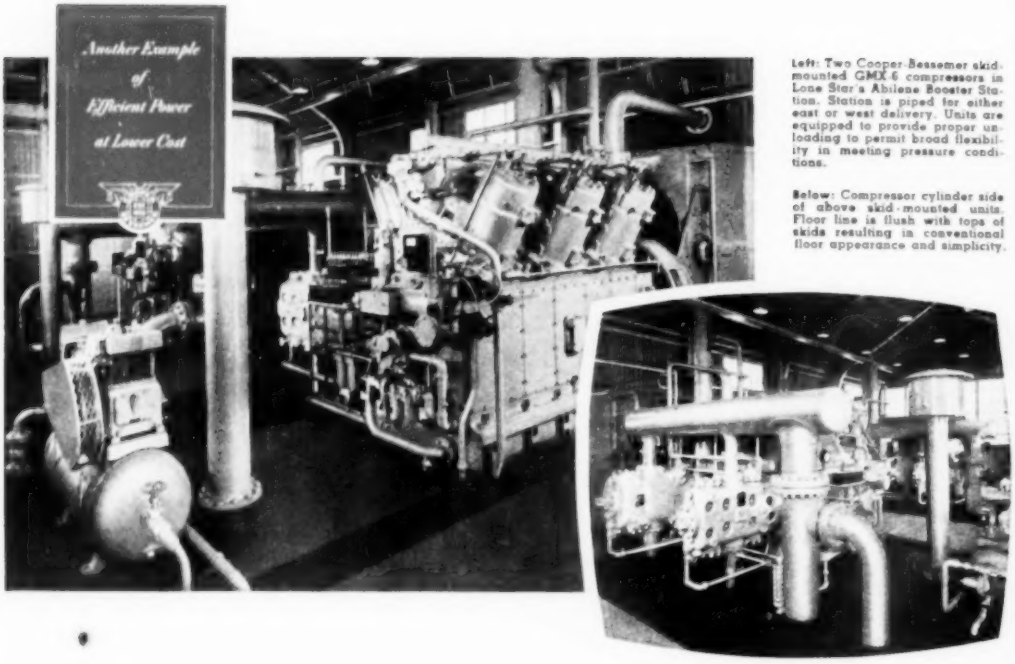
PP-5



Left: Two Cooper-Bessemer skid-mounted GMX 6 compressors in Lone Star's Abilene Booster Station. Station is piped for either east or west delivery. Units are equipped to provide proper unloading to permit broad flexibility in meeting pressure conditions.

Below: Compressor cylinder side of above skid-mounted units. Floor line is flush with tops of skids resulting in conventional floor appearance and simplicity.

GMX's at Lone Star's Abilene Booster Station

...2 "packages" of flexibility

IT MIGHT surprise you to know that the GMX's pictured opposite are skid-mounted units . . . 2 packages, factory tested and delivered complete with all auxiliary equipment. It's quite an advantage —made possible by the simplicity and extreme compactness of these modern Cooper-Bessemer compressors.

Secondly, and perhaps even more remarkable, is the unusual flexibility of this compressor set-up. The station is piped so that it can pump either east or west —necessitating compressors that would operate efficiently despite widely varying pressure conditions. These GMX's readily provided with the proper unloading facilities to permit such flexibility. And, with suction pressures running lower than anticipated, months on end, it's another example of how well GMX's can handle tough jobs.

If you have a compressor job coming up, tough or simple, get all the money-saving facts on modern, long-lived Cooper-Bessemer V-angles—GMX's, GMV's and GMW's. They're ready to cut your costs on any compressor requirement from 200 to 3,000 hp.

The **Cooper-Bessemer** Corporation

MOUNT VERNON, OHIO — GROVE CITY, PENNA.

New York, N. Y. Washington, D. C. Bradford, Penna. Parkersburg, W. Va.
San Francisco, Calif. Houston, Dallas, Greggton, Pampa and
Odessa, Texas Seattle, Wash. Tulsa, Okla. Shreveport, La.
St. Louis Los Angeles, Calif. Chicago, Illinois Caracas, Venezuela

(To obtain more data on advertised products see page 6086)

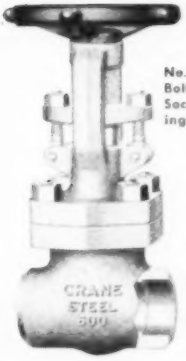
why CRANE 600-pound small steel gates are sure to meet your needs

You can't top these Crane Small Steel Gates for dependable performance on high pressure, high temperature lines . . . for ease of operation . . . for simplified maintenance. That's because they include design features normally found only in larger or more expensive valves.

Then too, these Crane valves are available in a choice of types to meet your particular requirements. For example, with union or bolted bonnets; with screwed, flanged, or socket-welding ends; and in trim materials recommended for all common fluids.

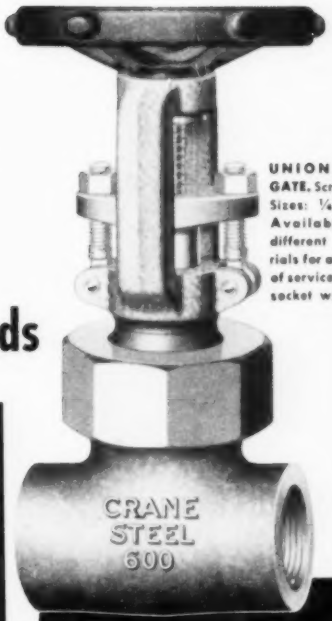
GET NEW DESCRIPTIVE CIRCULAR AD-1881

For complete information—including prices—about these longer lasting, easier operating Crane Small Steel Gate Valves. Ask your Crane Representative for your copy, or write direct. No obligation.



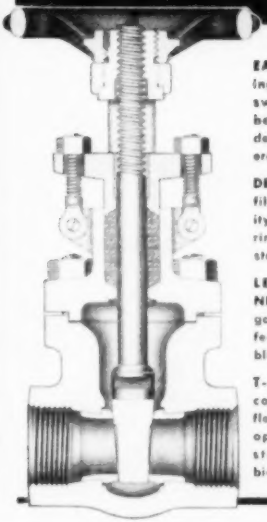
No. 3611XW. Bolted Bonnet Socket-Welding Ends

No. 3615XW. Bolted Bonnet Flanged Ends



UNION BONNET GATE. Screwed ends. Sizes: ¼ to 2-inch. Available in three different trim materials for a wide range of services. Also with socket welding ends

Easy to Operate... Easy to Service



EASY ACCESS to stuffing box assured by swinging gland eyebolts. Improved yoke design provides liberal working space.

DEEP STUFFING BOX filled with high quality asbestos packing rings maintains tight stem seal.

LEAKPROOF BONNET JOINT. Soft iron gasket in male and female joint cannot blow out.

T-HEAD DISC-STEM connection provides flexibility for smooth operation; prevents stem distortion or binding of parts.

Cross-section No. 3607XW. Bolted Bonnet Gate, Screwed

CRANE CO.

General Offices
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Announcing for late summer . . . a new source of pure aromatic hydrocarbons.

Naphthenes from West Texas Crude Oil

Platinum dehydrogenation

Diethylene Glycol Extraction

Benzene — 1° Nitration Grade
Toluene — 1° Nitration Grade
Xylene — Ten degree

Completion of the BTX plant represents another important addition to Cosden's organic chemical production.

ADDRESS INQUIRIES TO:
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COSDEN

PETROLEUM CORPORATION
BIG SPRING, TEXAS

Solvents • Cresylic Acids • Alkyl Mercaptens • Organic Specialties

(To obtain more data on advertised products see page 6961)

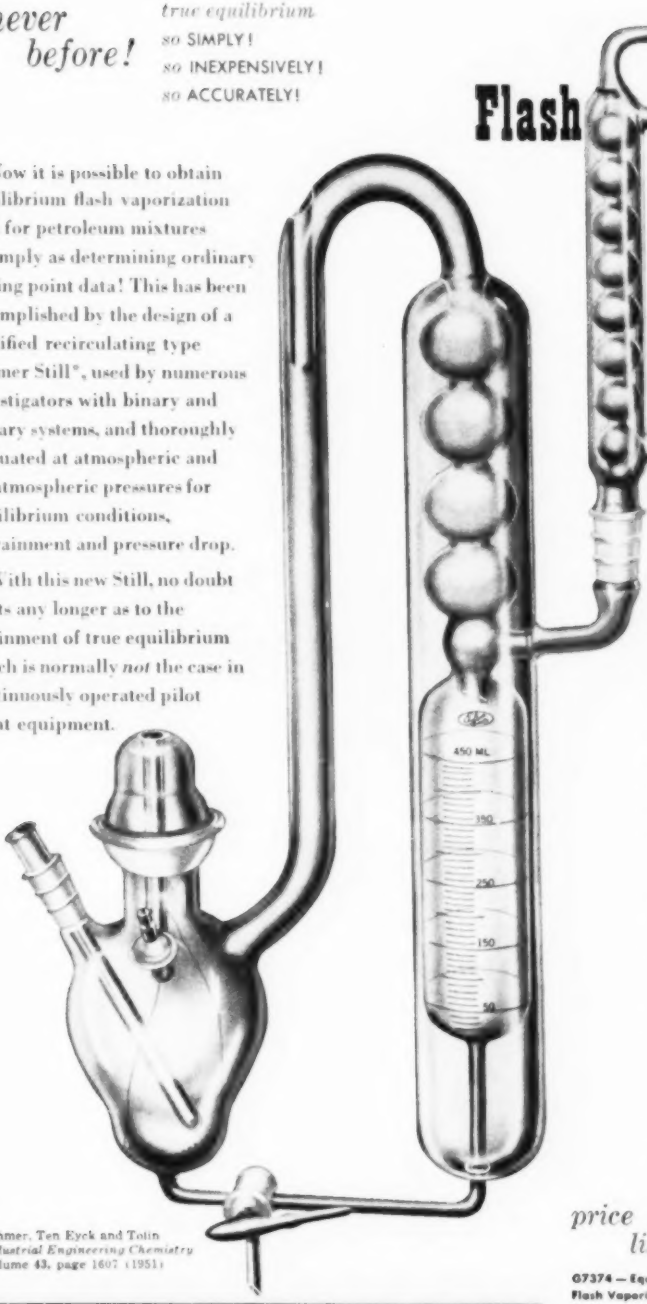
never before!

attainment of true equilibrium
so SIMPLY!
so INEXPENSIVELY!
so ACCURATELY!

Flash Vaporization Equilibrium Still

■ Now it is possible to obtain equilibrium flash vaporization data for petroleum mixtures as simply as determining ordinary boiling point data! This has been accomplished by the design of a modified recirculating type Othmer Still*, used by numerous investigators with binary and ternary systems, and thoroughly evaluated at atmospheric and subatmospheric pressures for equilibrium conditions, entrainment and pressure drop.

■ With this new Still, no doubt exists any longer as to the attainment of true equilibrium which is normally *not* the case in continuously operated pilot plant equipment.



*Othmer, Ten Eyck and Tolin *Industrial Engineering Chemistry* Volume 43, page 1607 (1951)

why it is wise to use the flash vaporization equilibrium still

- *It is a compact unit which may be set up on a laboratory bench top.*
- *The initial cost is a fraction of that for the continuous type.*
- *Only a small quantity of charge material is required per determination—e.g., 500 to 2000 ml. per flash curve as compared with about 2 barrels for the continuous type.*
- *It requires a minimum of routine attention from one operator who may carry on other work concurrently.*
- *It allows the determination of the initial boiling point of the mixture and all points of vaporization up to about 92%.*
- *There is negligible pressure drop through the unit. This permits reading of the pressure at a point where condensing vapors do not clog the manometer.*

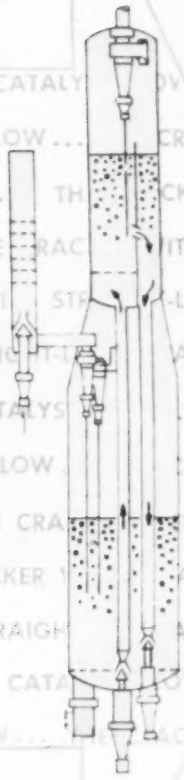
price list

G7374 — Equilibrium Still, Flash Vaporization, Othmer Type. Complete as illustrated with internal heating coil and connectors.
each **$139.50**

The EMIL GREINER Co.
20-26 N. MOORE STREET (E&G Co.) NEW YORK 13, N.Y.

The Logical "Next-step" in Economy and Efficiency . . .

Kellogg Orthoflow



ORTHOFLOW, the latest Kellogg advancement in Fluid catalytic cracking, not only merges reactor and regenerator into a single vessel, but provides *straight-line transmission* for both catalyst-oil mixture and spent catalyst—in a system free from slide-valves and expansion joints.

As a result, **Orthoflow** costs less to build, costs less to maintain and is more flexible in operation. It requires less structural steel, smaller foundations, simplified piping. Straight-line catalyst flow minimizes erosion and increases efficiency.

An **Orthoflow** unit can handle practically any feed-stock, from kerosene to the heaviest gas oil. High-boiling stocks are charged as liquids and vaporized by the hot catalyst, with minimum use of pre-heat facilities. Furthermore, **Orthoflow** units permit wide latitude in conversion . . . operate effectively over a wide range of feed rates to meet changes in a refinery's requirements.

Orthoflow, the logical "next-step" in catalytic cracking progress, derives from Kellogg's basic experience—dating from the inception of Fluid catalytic cracking—and the engineering of more than 70 percent of the world's total Fluid cracking capacity.

The latest issue of the KELLOGGRAM — "From Baton Rouge to Orthoflow" — presents the details on this new cracking development. Available on request.

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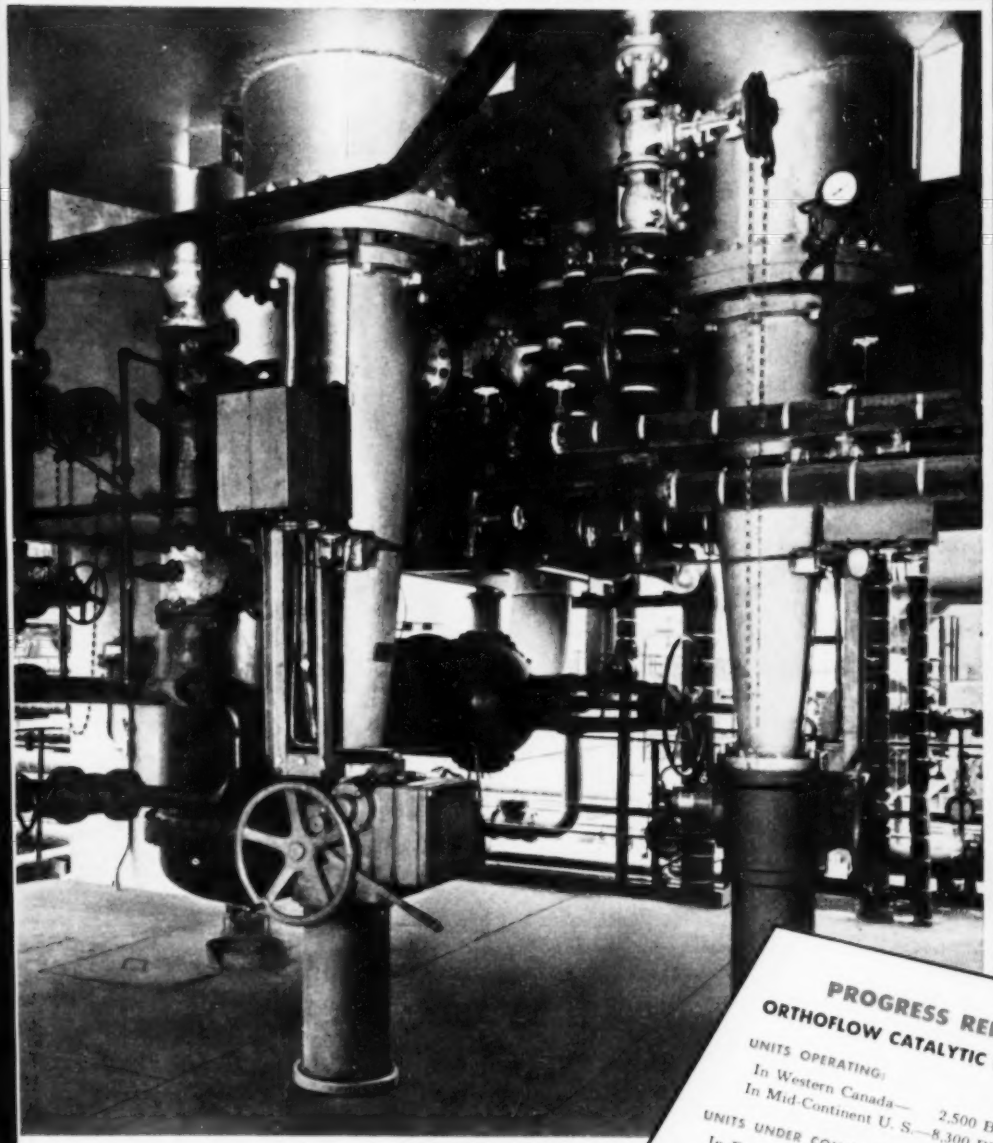

* Simplicity, the goal of all design, is the source of the important advantages in Kellogg's Orthoflow cracker. The cross section (left, above) reveals the simplicity of the design—note straight-line catalyst flow. Photo shows the specially-designed, swing-headed plug valves which control flow of catalyst and oil.

PROGRESS REPORT
ORTHOFLOW CATALYTIC CRACKERS

UNITS OPERATING:
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In Mid-Continent U. S.—8,300 BPD Unit

UNITS UNDER CONSTRUCTION:
In Eastern Canada—8,300 BPD Unit

UNITS IN ENGINEERING:
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In Mid-Western U. S.—17,000 BPD Unit
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In Europe—5,000 BPD Unit

.....for fifty-one years an integral part of petroleum refining progress!

Ever since you were knee-high to a hop-toad, you've heard about America's wonderful *natural resources*—the bountiful fertile fields, the towering timber growth, the boundless water power, and the untold wealth of gold, iron, oil, silver, coal and other natural treasures that lie buried in the ground.

Is it because America has *more* natural resources than any other country that Americans enjoy the world's highest standard of living? No—many countries have as much—some have more.

Then is it because Americans *do* more with what they've got?

Yes! And the reason is as plain as the nose on your face. It's because Americans are free to develop their natural resources—and their natural resourcefulness—in the wholesome climate of *open and strenuous COMPETITION.*

COMPETITION—not "regimentation"—is what eggs a man on to do his best.

COMPETITION—not government control—is what urges a business to give its customers ever greater value for their money.

So let's say "**NO SALE**" to the *ism* peddlers who would have us swap our U. S. A. system of free competition for their "planned" regimentation—trade our U. S. A. freedom and plenty for their serfdom and poverty!

* * *

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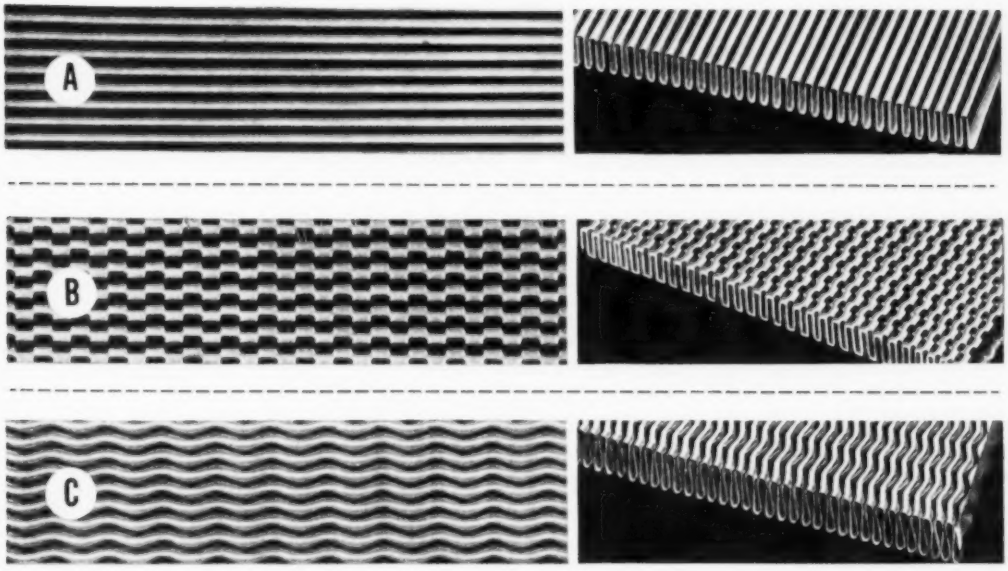
THE COMPETITIVE SYSTEM DELIVERS THE MOST TO THE GREATEST NUMBER



Three of the many types of fin section available.

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With Trane Brazed Aluminum Heat Exchangers, you choose from a great variety of surfaces in solving exactly your heat transfer problems. They may be straight and continuous (A). They may be serrated (B). Or they can be of herringbone design (C). With these basic designs, exactly the right surface can be selected to provide the correct ratio of heat transfer to pressure drop characteristics.

Many further variations of these general types are practical. The height and the thickness of the fin can be varied. So can the number of fins per inch. In fact, fins with entirely different patterns, heights and number of corrugations per inch can be used side-by-side to handle different fluids in the same exchanger.

Thanks to this great flexibility you can provide just the heat transfer, just the pressure drop volume, velocity number and direction of passes you want with Trane Brazed Aluminum Heat Exchangers.

Design flexibility is but one of the many advantages of Trane Brazed Aluminum Heat Exchangers. Compared to conventional exchangers, they produce more heat transfer efficiency in $\frac{1}{4}$ the space with $\frac{1}{4}$ the weight at approximately $\frac{1}{2}$ the cost.

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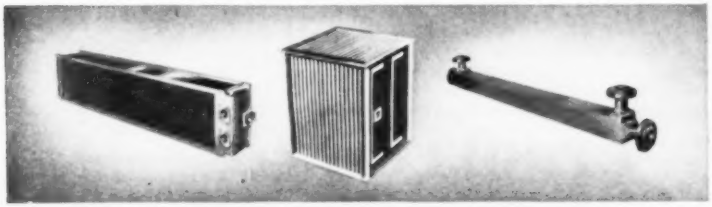
Whether the job calls for high or low temperatures or pressures, one stream or many, Trane Brazed Aluminum Heat Exchangers can be the answer. Contact your Trane sales office or write direct.



Here are a few of the many varieties of Trane Brazed Aluminum Heat Exchangers which are now in actual service: 1) A cross flow unit for liquid-to-gas exchange used for condensing purposes. 2) A cross flow gas-to-gas unit which is used for intercooling for aircraft engines. 3) A counter flow liquid-to-liquid exchanger for high pressure application.

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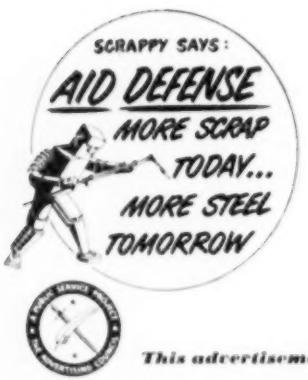
Part of the Mesabi Range may be **wasting away** in your plant



Natural resources don't last forever . . . not even the Mesabi Range.

But *you* can make them last *longer* . . . by helping to recover the *dormant* iron and steel wasting away in your plant.

Right now, more iron and steel *scrap* is needed than ever before to help maintain steel production. Lack of enough scrap—which normally represents 50% of the ingredients used in making new steel—would seriously hamper the nation in this critical period.

WHAT *YOU* CAN DO

To meet demands of military and civilian production, *your* help is needed. That means searching *your* plant for *more* scrap . . . any old idle iron and steel gathering dust and rust.

Your scrap is needed *now*.

Get *your* scrap salvage program going—*today*. Include non-ferrous scrap, too.

It tells how to conduct your own salvage program

For your copy, write to Advertising Council, 25 West 45 Street, New York 19, New York

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PETROLEUM PROCESSING

PETROLEUM CHEMICALS DIVISION

NEWS

May ★ One of a Series of Interest to the Petroleum Industry ★ 1952

Du Pont Purchases Plant Site in Texas

A 562-acre tract in the Beaumont, Texas area was recently purchased by the Organic Chemicals Department of the Du Pont Company. The Petroleum Chemicals Division, supplier of tetraethyl lead, is part of this department.

The plant site is bounded by the Neches River and the Kansas City Southern Railroad. Definite plans for plant construction on the new site have not yet been announced. The land, however, was purchased for the purpose of expanding the Company's regular manufacturing activities.

The location is conveniently close to an ample supply of petrochemicals . . . used in making many Du Pont products. There are now three major Du Pont Company plants in Texas, at Sabine, Victoria and Houston.

NEW DU PONT MARKETING AID...

Unique Mileage Calculator Now Available for Your Special Gasoline Promotions

Why does a motorist select *your* gasoline brand . . . or your competitor's?

Miles per gallon is, no doubt, one of his most important considerations—because he can see how it affects his pocketbook. That's why many car owners are interested in keeping score on gasoline mileage.

By giving the motorist an interesting gadget that helps him determine his mileage accurately, you can gain his friendship . . . and often create a favorable impression for your brand.

The new Du Pont gasoline mileage calculator is designed to help you do just that. It is essentially a circular slide rule with simple settings that tally miles-per-gallon performance.

The calculator accurately figures the mileage on fuel measured to the nearest fifth of a gallon. And a handy indicator, which the motorist sets with each tank filling, automatically keeps track of his previous mileage. But the tank has to be completely filled at each gas stop to enable the motorist to maintain a continuing check . . . which is, of course, to your advantage.

Complete instructions, plus *your* trade-mark and brand name are printed on the front of the calculator. It carries no other advertising. This makes it an ideal tie-in for your special promotions—such as the introduction of a new or improved gasoline, the opening of a new station, or as a low-cost write-in item for testing your advertising or radio program.

The Du Pont calculator design is available to oil companies who, in turn, would have them made with their own brand name and trade-mark in any desired quantity.

New Visual Training Aid On Blending Plant Safety Developed by Du Pont

"Safety" is always a password to the successful handling of tetraethyl lead. And uniform handling procedures are of prime importance in maintaining safety in the blending area.

Since tetraethyl lead was first used in gasoline in the early twenties when Du Pont developed a safe commercial method for making it, a variety of methods for training blending personnel have evolved.

THIS NEW DU PONT TEL SAFETY PRESENTATION can be clearly seen by a group of 20. And it is specially designed for convenient handling by the training instructor or discussion leader.

Now, to fill the need for a single, easy-to-understand tool for training prospective blending plant operators, and as a refresher course for experienced personnel, a carefully detailed turnover presentation has been developed by Du Pont. And this new visual training aid may well become the standard for training blending plant operators throughout the country.

CLEAR, SIMPLE

Stressing "correct operating procedures" as a means to safety, the presentation convinces viewers that correct operation, while not difficult, *is vitally important*. And the presentation is fortified with plenty of "reason why" to make its message penetrating.

For clarity and human interest, the turnover is made up of a series of easy-to-understand illustrations and diagrams. The simple, straightforward text on the back of the turnover is readily visible to the instructor, either for reading verbatim or as a guide for

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

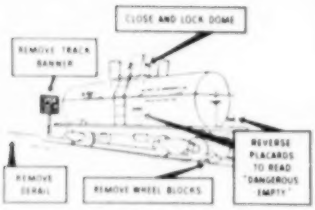
CONTINUED *Safety Turnover*

delivering the presentation with his own personal showmanship.

Big enough for visual impact, yet small enough for convenient handling, the 47 pages are 18½" by 24". Color has been added to many of the illustrations to show graphically and vividly the actual flow of liquids during the unloading and blending operations.

STEP BY STEP

The presentation is divided into two sections—tank car unloading and blending plant operation. Health precautions and the use of proper procedures are analyzed step by step.



A TYPICAL PAGE shows graphically the important steps in preparing a TEL tank car for release.

In addition to the actual turnover, protected by an attractive "Fabrikoid" binder, an "Instruction Manual" has been prepared to assist the speaker in the initial stages of becoming familiar with his presentation. The handy 8½" by 11" size of the manual permits the speaker to study his material at his desk, at home, on a plane or train without the necessity of handling the larger turnover.

NEVER touch anything contaminated with TEL compound without rubber gloves.
ALWAYS bathe thoroughly after working with TEL

HUMOROUS FIGURES add interest to a serious point.

Suitable for either the novice or experienced blending crews, the new Du Pont turnover follows the style of the National Safety Council's "Safetygraph."

Coordinator of Du Pont District Laboratories

THE PROMOTION of ARTHUR F. BOWE to the position of Laboratory Coordinator was recently announced by the Du Pont Petroleum Chemicals Division.

Since 1949, Bowe has been manager of the Division's Eastern District Laboratory at Wilmington. This laboratory serves refineries on the Atlantic seaboard of the United States. He had previously been acting manager of the Gulf Coast District Laboratory at Houston, Texas, and supervisor of the analytical section of the Du Pont Petroleum Laboratory.

Before joining Du Pont in 1947, Bowe was with the Cities Service Oil Company at East Braintree, Mass. He was graduated, with a B.S. in chemistry, from Tufts College in 1939 and during his senior year was a teaching assistant in chemistry.

ARTHUR F. BOWE

Du Pont Historical Highlights

An early supplier of Du Pont was a Philadelphia firm that sold kegs to the powder mills. The containers were all sizes and qualities, causing confusion in sales and frequent losses from breakage and dampening of the powder. Later, Alfred Victor du Pont, son of the founder, built his own cooperage shop, designed a satisfactory standard keg and, thereafter, made the containers on the mill premises.

Today, containers, ranging all the way from paper envelopes to the tank cars carrying Du Pont's TEL, rank among the most important products Du Pont purchases. And Du Pont buys from more than 30,000 firms. Petroleum companies, suppliers of the petrochemicals used in making Du Pont products, rank well up among the firms supplying the largest volume of commodities bought by Du Pont.

MOVIES AND LITERATURE AVAILABLE

Here is a partial listing of the movies, bulletins, reports, booklets and aids available to you through the nearest Du Pont Petroleum Chemicals Division district office:

Safety for the Small Refinery—A 42-page book on how to set up an effective small refinery safety program. Serial A-2848

Stability of Present-Day Gasolines—A 12-page paper on the value of storage tests—as compared with induction period—for determining stability of modern gasolines. Serial A-3199

Pipeline on Wheels—A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

Prints of Du Pont films are available to oil companies for training and public relations purposes. They may be borrowed or purchased.

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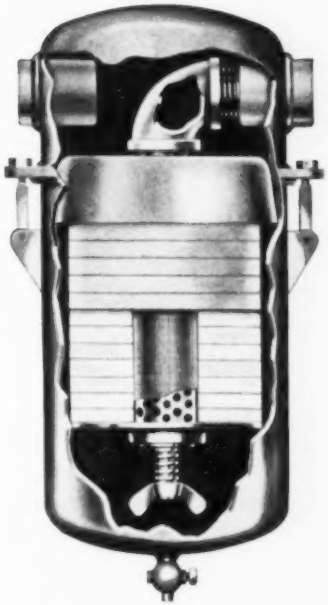

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DOLLINGER

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ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

(To obtain more data on advertised products see page 696)

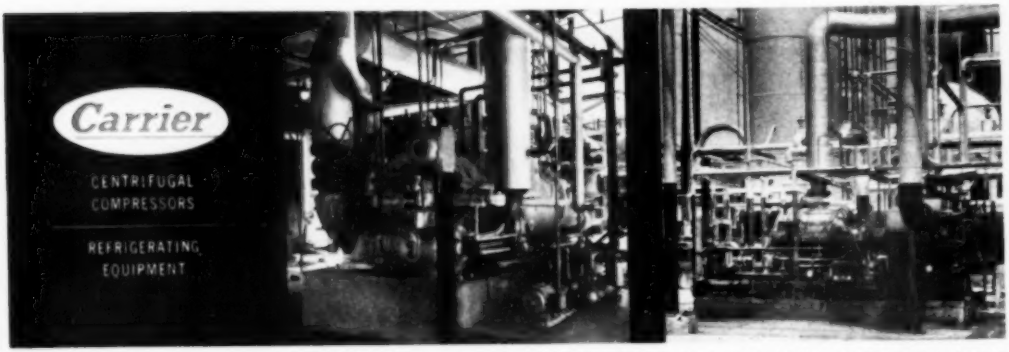
What makes them all go for one?

You know that all over the country alkylation units are being built or reactivated to supply higher octane gasolines for both defense and civilian needs. But did you know that just about every one of them uses the Carrier Centrifugal Compressor?

Why this amazing record? Well, first, there's no need for complex control equipment when you use the Carrier Centrifugal – it maintains exact temperature and pressure levels without them. Then, too, in case acids should ever escape, the Carrier Centrifugal Compressor – and only the Carrier – gives you the extra protection of lead-coated wheels.

But we think one single important word tells the main reason for the Carrier Centrifugal's popularity. *Experience.* Experience for more than thirty years, building more multi-stage centrifugal compressors than anyone else in the business. That kind of experience is worth taking advantage of, don't you agree?

We'd like you to have our catalog, "Centrifugal Compressors for Industry." Ask for it at the nearest Carrier office, or write Carrier Corporation, Syracuse, New York.



Both the hydrofluoric acid alkylation unit at Sinclair-Refining's Corpus Christi plant (left) and Mid-Continent Petroleum's sulphuric acid alkylation unit in Tulsa use Carrier 550 series Compressors. Carrier Centrifugal Compressors are built in standard designs from 2000 to 40,000 cfm., with three to seven wheels.

The Man Who Hates "Desk Jockeys"

Unlike those of us who, of necessity, are swivel-chair pilots, Virgil Guthrie has a modus operandi that makes it mandatory for him to be on the move.

"Guth", editor of *Petroleum Processing* and a veteran of 35 years in reporting refining activities, found out long ago that the way to ferret out accurate technical and marketing information in the petroleum refining industry is to be "on the spot". And, like Guthrie, *Petroleum Processing*'s entire staff, the largest and most experienced editorial staff exclusively devoted to the specialized interests of oil refining, believes that by being present where the things they write about are happening, they can best be of service to refining men everywhere.

That's why refining men accept *Petroleum Processing* as their source of accurate information on technical developments in the industry and for complete and expert analyses of market trends. That's why these men, key buying factors in this market, will read *your* message . . . if it's printed in the pages of *Petroleum Processing*, the publication that's edited by experts, for experts in the refinery industry.

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REACHING THE MOST REFINERY READERS

A Platt Petroleum Publication

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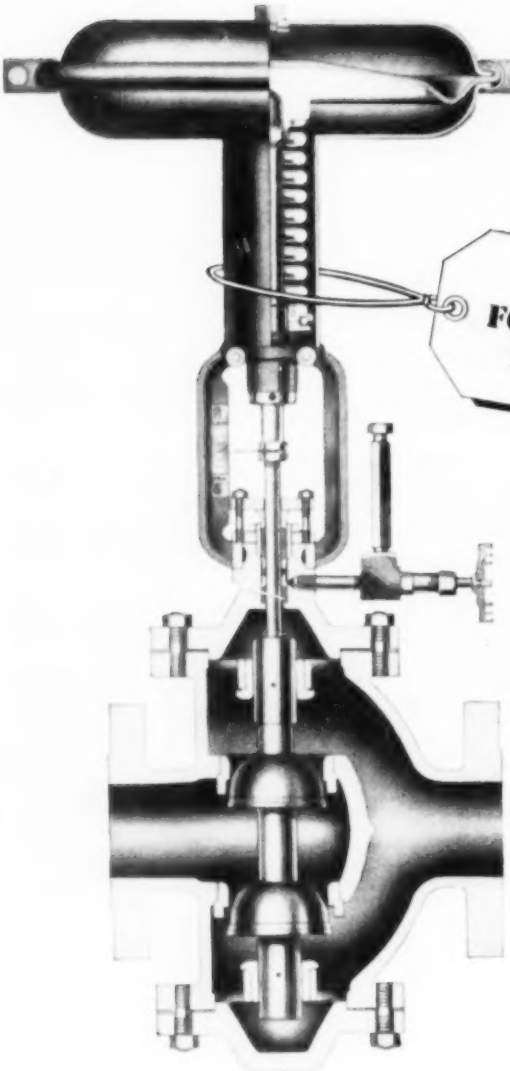

AMERICA'S LEADING INDUSTRIES PUT THE STAMP OF APPROVAL ON KIELEY & MUELLER CONTROL VALVES

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All over the country leading companies in the process industries are solving tough problems with K & M control valves, designed especially for precise and positive control by instrumentation.

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There is a qualified K & M representative near you, eager to discuss your control problems and able to provide the most satisfactory solution.

This extremely accurate circular slide-rule type K & M valve capacity calulator includes correction scales for steam quality, liquid and gas specific gravity and a flowing temperature scale for gases. Sent without charge in response to a request on your business stationery.

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Valve Makers Since 1879

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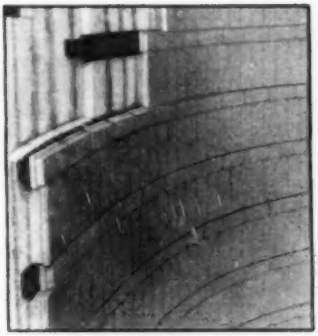
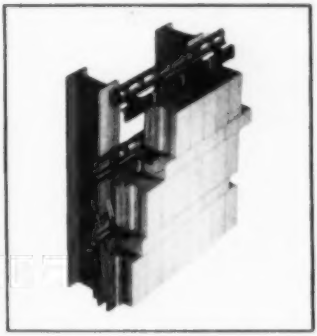
Thin refractory walls—backed up with insulation—cut the costs of oil still installations. When tile are shaded by tubes, 3" walls are used; 4½" walls are specified for exposed walls of moderate temperatures.

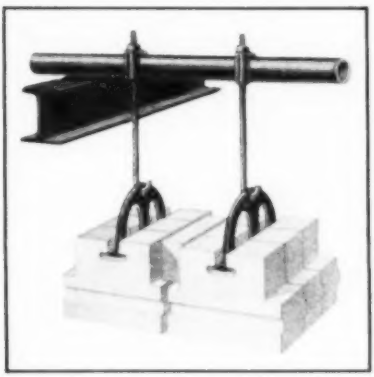


Here is a Bigelow-Liptak wall curved to fit a 25-foot diameter vessel lining. It is backed up with insulation and is hung from modified circular brackets. B-L walls and arches can follow any furnace contour.



When the going is really tough, B-L engineers select rugged 7" walls. Unit-suspended B-L walls eliminate cumulative loading and expansion. Repairs are to damaged tile, adjacent areas are untouched.

Heavy-duty B-L linings reduce oil still repairs



This pendulum-type Bigelow-Liptak arch permits the tile to swing freely in four directions. There is no cumulative loading or expansion thrusts against side walls. Arches are available in any thicknesses, follow any contour. Radial noses are similar.

Repairs are made quicker and at a much lower cost when oil stills are lined with Bigelow-Liptak walls and arches. Because heavy-duty refractories and insulation are used throughout, B-L linings stand up under the toughest of operating conditions.

Refinery boilers are enclosed with special applications of the same type of construction outlined above. When tubes are closely spaced, Bigelow-Liptak's new tube-supported wall is used. Both oil stills and boilers are covered with B-L's casing—TEXAD*. This new covering method is weatherproof, looks better, and replaces steel plate.

Catalogs describing refinery furnaces, the tube-supported wall, and TEXAD* are available upon request. Write today.

*Trademark

BIGELOW-LIPTAK

Unit-Suspended Walls & Arches

BIGELOW LIPTAK Corporation

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BIGELOW-LIPTAK OF CANADA, LTD., TORONTO, ONTARIO

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1 DEPENDABLE QUALITY

Production of Nalcat Cracking Catalysts is rigidly controlled to assure uniform high quality in every pound of material delivered to users.

2 MEETS SPECIFICATIONS

Whether you use standard Nalcat grades, or require catalyst to your specifications, Nalcat is guaranteed to meet specifications fully.

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Delivery, as promised, can be an important factor in catalyst purchases. When you buy Nalcat, you can be certain of delivery on the dot.

Nalcat FLUID CRACKING CATALYSTS

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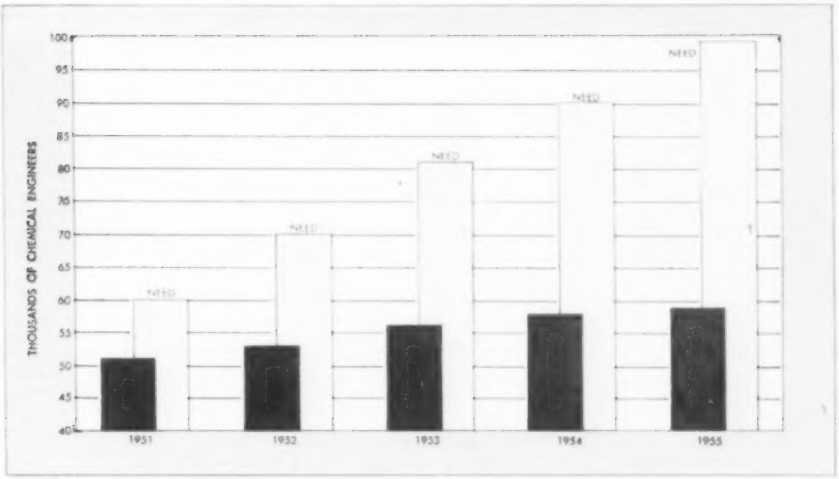


FIG. 1 — Illustrates chemical engineering shortage as it exists today with estimates of future needs

Is Specialized Engineering Needed?

Refining industry must promote specialized training to meet growing manpower needs

By EUGENE F. GIBBONS, Staff Writer

THE refining industry needs engineers with specialized skills. Specialized training in refinery operations covers vast numbers. For instance, take the petroleum refinery engineer. He is a chemical engineer who has been trained to the specific needs of the refinery industry, processwise. Other specialists are also needed. Today's complex petroleum processes call for engineers and technicians of all types to operate, design and maintain refineries. In addition to the petroleum refinery engineer this means corrosion engineers, combustion engineers, lubrication engineers, plastic engineers, instrument engineers, and others, must combine their skills to do the job. Whether or not these skills should be taught on the undergraduate level is debatable.

Despite the obvious need for engineers with specialized skills, a survey recently concluded by PETROLEUM PROCESSING showed that leaders in education and the oil industry alike generally abhorred the suggestion that petroleum refinery engineering or other types of specialized training be taught in American colleges and universities on the undergraduate level. The fact of the matter is that specialized curriculum is offered on the undergraduate level and is being encouraged. Table 1 lists the schools with a petroleum refinery engineering, and natural gas engineering curriculum offered to undergraduates.

And, with the acute engineering shortage apparently getting worse, Fig. 1 indicates the chemical engineering situation, the petroleum industry itself is taking many more steps than in the past to insure itself of at least a minimum number of technical operating personnel. Fellowships, scholarships, research grants, trust funds and the like have been established in various fields of petroleum science. In all fairness, however, it must be pointed out that a majority of these grants are directed to graduate study.

For the purpose of argument in this article, we will pit petroleum refinery engineering against the more broad engineering applications of chemical engineering. In so doing, we will attempt to show that there is a definite need for specialized training on the undergraduate level, why this training does exist, and that an individual is not limited to one field by specialization.

The main objection to specialized training is that it does limit one to a single field, and doesn't provide him with a diversified background which would enable him to choose his vocation from a number of other fields.

Why, then, is petroleum refinery engineering offered to undergraduates?

To promote specialized training in the petroleum industry.

Although individuals may disagree, an analysis of the facts show this to be the only answer. It must be acknowledged that America is the leading industrial nation on earth, and to hold that position she must expand her industries. To expand our industries means that we must pinpoint engineering science to a greater degree than in the past. It's a matter of whether we want to or not, and it seems as though we want to. A specialized curriculum for undergraduates even suggests the need for specialized engineering.

Survey Findings

The PETROLEUM PROCESSING survey posed five questions in an attempt to determine whether or not a need exists for specialized training of pe-

Table 1—Schools Offering Petroleum Refinery Engineering, Natural Gas Engineering and Degrees Awarded

School, Location	Bachelor of Science Degree Awarded In
[illegible]	Petroleum Refinery Engineering
[illegible]	Chemical Engineering; Petroleum Refinery Engineering Option
[illegible]	Chemical Engineering; Includes Curriculum of Petroleum Refinery Engineering
[illegible]	Petroleum and Natural Gas Engineering
[illegible]	Chemical Engineering; Includes Curriculum of Petroleum Refinery Engineering
[illegible]	Petroleum Refinery Engineering; Chemical Engineering
[illegible]	Natural Gas Engineering; Includes Chemical and Natural Gas Engineering Curriculum
[illegible]	Chemical Engineering; Petroleum Refinery Engineering Option
[illegible]	Petroleum Refinery Engineering

troleum refinery engineers. Those queried were leading educators at schools with and without petroleum engineering on their curriculum, and men in the oil industry.

1) Is there a need for specialized training of petroleum refinery engineers?

Walter J. Ewbank, director of research, Cato Oil and Grease Co., replied: "When it comes to graduate level work, I feel that there is a definite field for highly specialized training in refinery engineering."

A spokesman for a major oil company answered: "Not for a major oil company. In the case of a small refiner who might be hiring only a few engineers, specific academic training in petroleum refining might be useful."

The pro and con of this question was carried further by a remark by Mr. M. Halpern, vice president, The Texas Co., who said: "The average engineering graduate is not well trained for refinery design work because he does not receive in school the necessary specialized instruction in current practices in refinery operation. This is understandable since chemical engineering students do not have the time for such specialized training for all the different industries in which chemical engineers may be employed. For this reason, there is a definite need in refinery design work for petroleum refinery engineers who have had the necessary specialized training."

Kenneth A. Kobe, graduate advisor at the University of Texas, had this to say: "Some specialized training for men going into the petroleum refinery industry is desirable, but it is our belief that it should be given on a graduate basis." Carl C. Monrad, head of the chemical engineering department at Carnegie Institute of Technology, commented: "The petroleum industry now needs men with broad training, not specialized training at the undergraduate level. I believe you will find that in general, well trained chemical engineers have done much better in the petroleum refinery business than petroleum refinery engineers."

E. R. Gilliland, department of chemical engineering, Massachusetts Institute of Technology observes that "there is undoubtedly a need for specialized training for petroleum refining but we believe this specialized training should be given by the industries involved rather than the universities."

Paul Buthod, head, department of refining, University of Tulsa, added a very significant comment, one which is being acted upon currently by the refining industry: "I believe that industry should consider programs of selecting some of their better men, and sending them back to school for advanced degrees rather than depending on the hit and miss proposition of waiting for men to go to school on their own."

Recently Socony-Vacuum Oil Co. awarded 1952 Incentive Fellowships to two of its employes to encourage scientific studies by company people and to promote better understanding among members of the teaching profession and industry. Salaries of both men continue during a period not to exceed three years to enable them to earn higher academic degrees. Candidates for the fellowships are required to have a bachelor's degree and to have been employed by the company for at least two years.

2) What distinguishes chemical engineering from petroleum refinery engineering?

Educators and men in the field were fairly well agreed on this point and the answer is reflected in the remarks of Elwood G. Glass, Jr., industrial relations assistant to the technical manager, Standard Oil Co. (Ohio). He thinks that "The difference between the two is essentially one of emphasis. The chemical engineer is trained in unit operations dealing with a variety of industries. The petroleum refinery engineer would have such engineering training aimed exclusively at petroleum processes. In addition he might have special courses in crude assay, specific oil and gas analysis."

W. T. Schrenk, chairman, chemical engineering department, University of Missouri School of Mines and Metallurgy says that "The basic background is identical. Chemical engineering offers more general training. Petroleum refinery engineering offers more specialized training at the senior level."

"In our opinion what distinguishes a chemical engineer from a petroleum refinery engineer is that the first has a general professional training, while the latter has a vocational training," asserted E. R. Gilliland (MIT).

James Coull, professor and head of the chemical engineering department at the University of Pittsburgh tersely commented that "petroleum refinery engineering is chemical engineering."

3) What are some of the most outstanding shortcomings of today's engineering graduates?

Although this may be considered an aside from the main point of the article it does show some of the weaknesses found in new engineering graduates and indicates apparent faults with engineering curricula.

George Granger Brown, dean of the college of engineering at the University of Michigan, remarked: "In general we find the graduates somewhat spoiled because of the great many jobs and opportunities which have been offered to them, and therefore many of them are not properly motivated to really go to work. Another universal limitation is the apparent inability of many graduates to express themselves effectively in the English language."

J. Porter Langtitt, senior vice president of the Pure Oil Co., had this to say: "Engineering students, as soon as they come from the universities with undergraduate degrees today, know too little and certainly have only a very thin smattering of subjects dealing with economics, finance, history, psychology, philosophy, and English."

Mr. Glass (Ohio Standard) remarked: "Engineers are too specifically trained and have had too little of the humanities and other subjects aimed at enabling them to live their daily lives. We might say in this respect that one of the things we look for in hiring new engineers is a broad interest pattern."

W. L. Ingraham, general manager, personnel department, Standard Oil Co. (Calif.) is satisfied that "The training received in any of the first-class engineering schools meets company requirements for new hires. Perhaps more emphasis should be put on the use of good, concise English, both written and oral."

4) How long does it take an engineering graduate to adapt himself to the practical needs of the refinery industry?

Sharp differences of opinion can

be noted here, from the following comments.

"It has been our experience that a well trained chemical engineer should be adapted to the practical needs of the refining industry by the end of his first year of employment," said E. J. Henry, vice president, Atlantic Refining Co.

Mr. Glass (Ohio Standard) finds "It is our experience that an engineer does not get his feet firmly on the ground for at least two years after leaving school. We devote some nine months of this first two-year period to a formal, full-time training course. This formal training helps shorten the transition time and gives the engineer a broad background which can be used in any job he may fill with the company."

R. W. Stewart, publicity and information division, public relations, Shell Oil Co. commented: "The first three years are, in effect, largely a period of training. However, Shell has a formal training program for new engineers ranging from three to twelve months. We have found it desirable to place most college graduates in such training courses to aid in the transition from the classroom to the refinery."

Comments from educators were surprisingly optimistic. Carl C. Monrad (Carnegie Tech) emphatically stated that "Most chemical engineers begin to earn their salt within a year after graduation. I am sure that most of them know more petroleum refining at the end of this time than the petroleum refinery engineer." E. R. Gilliland, (MIT) remarked: "A large number of our graduates go into the petroleum industry and we feel that they are successful and begin making a very definite contribution within a few months after they have joined the organization." W. T. Schrenk, chairman, chemical engineering department, University of Missouri, School of Mines and Metallurgy, answered briefly: "Three to twelve months. This depends on the individual and what is expected of him." R. L. Huntington, professor, School of Chemical Engineering, University of Oklahoma, quite shrewdly observed that "The time required for students to adapt themselves varies from one to ten years." Prof. Kobe (U. of Texas) replied "It is our belief that our chemical engineers adapt themselves to the practical needs of the refining industry in a matter of four to six weeks."

5) How can private industry help promote this specialized training? Is the establishment of scholarships, making research grants and the like, the answer to the problem?

W. M. Holaday, director, Socony-Vacuum Laboratories, offered the following plan: "Specialized training can be promoted through, (a) contacts between industrial laboratories, engineering firms and universities; (b) part-time employment of engineering professors as consultants to engineering, manufacturing and research departments; (c) employment of college students and professors in petroleum refineries, laboratories and engineering departments during vacation periods; (d) industry participation in engineering technical society activities and seminar meetings at universities."

Mr. M. Halpern (The Texas Co.) does not feel "that the establishment of scholarships or making research grants is the answer to the problem, although establishment of such scholarships or grants should contribute toward greater emphasis by schools on refining industry problems. The establishment of more cooperative courses by schools should materially assist in developing petroleum refinery engineers."

Prof. Kobe (U. of Texas) added: "Private industry is doing something now to promote specialized training and stimulate interest in the refining industry. Usually, this is in the form of research fellowships. For example, we have here at the University of Texas, fellowships sponsored by Gulf Oil Corp., Humble Oil and Refining Co., and The Texas Co. The chemical companies are likewise doing their bit to encourage graduate students, for we have fellowships sponsored by Carbide and Carbon Chemicals Division, E. I. du Pont de Nemours and Co., Dow Chemical Co., Ethyl Corp., and Jefferson Chemical Co. More fellowships, particularly to encourage graduating men to continue for the master's degree, would be exceedingly helpful. Scholarships for outstanding Junior and Senior students would focus attention on the refining industry. Probably the thing that would bring student and industry together in the best manner would be a greatly increased program of summer jobs."

Mr. Kobe's remarks emphasize that specialized training does exist and is being extended by the refining and chemical industries.

A final comment on Question 5 comes from J. D. Lindsay, head of the chemical engineering department at Agricultural and Mechanical College of Texas, who deduced the following: "Question 5 tends to imply that the answer to Question 1 is 'yes.' I am not sure that industry wants to promote specialized training in petroleum refinery engineering. It is my feeling that chemical engineering is a very broad training and that it would be a step in the wrong direction to put in a course with specialized training in refinery engineering."

As Prof. Lindsay has pointed out, Question 5 was directed with the thought of implying a "yes" answer to Question 1, i.e., there is a need for specialized training. Prof. Kobe's answer to Question 5 shows us that the refining and chemical industries are interested in specialized training in their respective fields.

Five Year Course

Because there is a need for specialized training and since it is available to undergraduates we contend that it should be offered to some Juniors, outstanding Seniors, and graduate engineers. From a practical standpoint it is necessary. Idealistically, it is not.

Even in schools with petroleum refinery engineering curriculum, specialized courses are not offered usually until the third year in a four-year course. A very suitable curriculum is offered by A. and M. College of Texas, where a five year course in chemical engineering leads to a B. S. degree in both chemical engineering and petroleum engineering. The curriculum includes all of the courses required in the four year chemical engineering and the four-year petroleum engineering program. It is intended to provide a background so that the graduate may have the necessary fundamentals to engage in refining, natural gasoline, development, production, and transportation phases of the petroleum industry. Table 2 lists the courses required to obtain the bachelor's degree in petroleum engineering-chemical engineering at Texas A. and M.

The premise that specialization limits one is not true. Fundamentals are still dealt with even in these courses. They are only applied more intensely with a specific process or industry in mind. The perception and engineering intelligence of the individual enables him to apply these principles to similar needs, regardless of the industry. For instance, take a look at the "specialized" curriculum of Texas College of Arts and Industries, Kingsville, Tex. Their program is listed as a natural gas engineering curriculum, and is offered to help supply the demand for technically trained men in the petrochemical industry. They introduced a course in 1935, whereby the processing of liquid and gaseous fuels is traced through a refinery with special attention directed to the latest procedures of polymerization, dehydrogenation, alkylation, and isomerization. (All of these are chemical engineering processes, in this instance, directed to a specific end.) Then the chemical derivatives of natural gas are studied along with methods of their production such as oxidation, chlorination, decomposition and nitration. (Again, all chemical processes directed to a specific end, but still fundamental in nature.) Finally, modern applications of the Fischer-Tropsch Process are studied, such as the Hydrocol Process, and considered

Table 2—Five-year Curriculum at A. & M. College of Texas, Which Leads to a B. S. Degree in "Petroleum Engineering-Chemical Engineering"

SOPHOMORE SUMMER SEMESTER*

	Hrs.		Hrs.
Basic Surveying	3	Thermodynamics	3
Engr. Mechanics	3	Petrol. Geology I	3
	6		6

JUNIOR YEAR

First Semester	Hrs.	Second Semester	Hrs.
Chem. Engrg. Fluid Dynamics	3	Chem. Engrg. Fluid Dynamics	3
Operations Lab.	1	Operations Lab.	1
Org. Chem.	3	Chem. Engrg. Lab.	2
Physical Chem.	3	Physical Chem.	3
Petrol. Geology	3	Org. Chem.	3
Surveying (Engrg.)	2	Petrol. Metallurgy	3
Mathematics VII	3	Petrol. Refining I	3
Hum. Studies	3	Hum. Studies	3
Elective	3	Mathematics (Engrg.)	3
		Elective	3
	24		27

SENIOR YEAR

First Semester	Hrs.	Second Semester	Hrs.
Chem. Engrg. Unit Operations	3	Chem. Engrg. Unit Operations	3
Operations Lab.	1	Process Control and Instrumentation	3
Chem. Engrg. Lab.	2	Petrol. Refining II	3
Petroleum Engrg. Lab.	1	Mechanics of Materials (Engrg. Mech.)	3
Petrol. Refining III	3	Petrol. Engrg. Lab.	1
Petrol. Engrg. Design	3	Petrol. Engrg. Design	3
Petrol. Engrg. Seminar	1	Petrol. Engrg. Seminar	1
Petrol. Engrg. Lab.	1	Petrol. Engrg. Lab.

ogy for which they are informed of research and developments applicable to the field of petroleum.

Asserts Need for Specialized Skills

Frank M. Porter, president of the American Petroleum Institute, keynote speaker at a Petroleum Engineering Management Conference sponsored by the University of Oklahoma on March 14, 1952, emphasized that "The oil industry has not only made extensive use of trained technical men but also has a growing need for more and more men of specialized skills and talents. The industry already has a great many men of this type, but the market is never saturated. As the industry grows and expands, so does the need for men with special skills and attitudes."

Pan-Am Southern Starts Practice School To Train Specialized Engineers

UNDER THE GUIDANCE of Dr. M. M. Gilkeson, second from left, Tulane University undergraduate students locate unit installations at Pan-Am Southern's Destrehan refinery (this month's cover)

PERHAPS the most constructive of all plans for promoting specialized training has already been undertaken by Pan-Am Southern Corp. In conjunction with Tulane University, Pan-Am has set up a practice school at their Destrehan refinery. Six outstanding senior chemical engineering students from Tulane have been chosen to participate in the experimental school. Since the start of the February semester this year, these students have been working a five-day, forty-hour week at the refinery. They will receive 18 semester hours credit, the equivalent of a full semester's work at the University. Typical problems undertaken by these "student oilmen" are: 1) testing the efficiency of heat transfer in heat exchangers auxiliary to the refinery's crude unit, 2) developing a solution to the problem of inadequate ventilation in the grease compounding plant, 3) testing the capacity of the refinery's product distribution system, 4) designing treating plants for gasoline and distillate fuel finishing, 5) designing steam line layout for heating of a lube oil storage tank, and 6) studying distillation column performance to determine methods of evaluating plate performance on separation of wide boiling fractions.

This chemical engineering practice option is designed to continue the education of "selected students" through the employment of these fundamentals on the technical problems faced in industry. The school is under the supervision of Dr. M. M. Gilkeson, assistant professor of chemical engineering at Tulane. He is working in close cooperation with Howard A. Parker, director of Pan-Am's technical department and members of Pan-Am's technical staff.

Pan-Am Expanding

An extensive expansion program is now in progress at Pan-Am Southern, one which will offer ideal conditions for undergraduate students and graduate students in the future. A new fluid catalytic cracking unit, an alkylation unit, a delayed coking unit and the first fluid hydroformer ever to be built are now under construction. Future plans of the practice school program call for participation of 15 to 20 students at the school during both Fall and Spring semesters.

This is the type of program which is needed to shorten the transition time from classroom to refinery. It is a practicable, working plan. Both the student and the employer profit by its existence. Here the student gets his hands dirty, sees how big business operates. He experiences the sensation of actually being an active participant in refinery operations. His information is first-hand. He gets his first opportunity at "human engineering." Each student is given a chance for self-evaluation as a result of his performance in the school. Thereby, he decides whether to specialize further.

ACS Seeks Solution

Recently the American Chemical Society appointed a 16-member committee on manpower, to survey the nation's manpower needs and formulate a broad program to assure an adequate supply of qualified chemists and chemical engineers. Promoting specialized engineering among outstanding engineering students could be the means of alleviating the present shortage of trained engineers. Whether the committee will incorporate any methods, such as the program undertaken by Pan-Am Southern and Tulane, is problematical. Even if they do not it appears as though specialization in the engineering field is here to stay, even on the undergraduate level. We maintain, as mentioned previously, specialized engineering should only be available to students of outstanding ability on the undergraduate level, but certainly cultivated among graduate engineers. American industry needs engineering specialists to expand her industries and remain a bulwark in the industrial world.

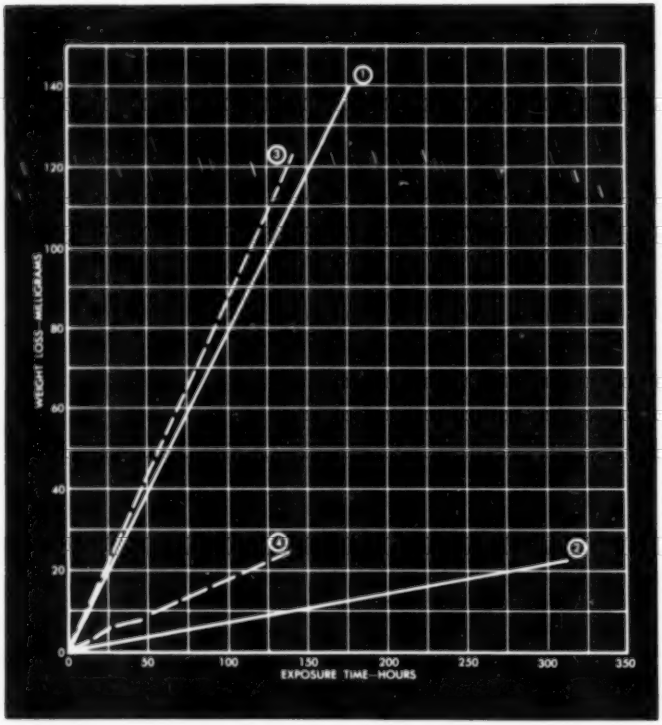


FIG. 1. Weight loss curves.

Cooling Water Treatment With Surface Active Materials

By W. F. OXFORD, Jr.*
Sun Oil Co., Beaumont, Texas

LARGE quantities of water are used for various cooling purposes in industry. This may be for cooling condensers or for cooling internal combustion engines. The source may be ground waters, surface waters, or sea waters. In general, cooling systems may become clogged with scale, corrosion deposits, sediment, or organic growths.

The principal scale forming material in cooling systems is calcium carbonate formed by the decomposition of calcium bicarbonate into calcium carbonate, carbon dioxide and water, as shown in the following reaction: $Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O$.

The purpose here is to report the experiences encountered in the use of surface active agents in preventing scale and corrosion in the circulating cooling tower water of gas compressor plants.

The specifications for cooling water vary so widely for various industrial applications that the only general specifications that can be given are that the water should not form heat insulating scales or other clogging deposits either organic or inorganic and that it should not be unduly corrosive under the particular conditions of use or re-use. There are three general classifications on the basis of conditions of use as follows: (1) Once-through-and-to-waste system, (2) Once-through-and-then-used-for other-purposes in cooling systems, (3) Re-circulated cooling system.

Cooling water treatment is rather well known to the art and much information concerning proposed treatments is available in the literature. In general, however, conventional cooling water treatment may be effected by one or more of the following processes: (1) acid process, (2) cold lime process, (3) Zeolite process, (4) lime-Zeolite process, (5) Coagulation followed by settling or filtration, (6) iron and manganese removal, (7) aeration, (8) chlorination and copper sulfate treatment, (9) polyphosphate treatment.

The above processes are not discussed in detail inasmuch as they are well known to the art of water treating.[1]

It was found that a mixture of high molecular weight substituted glyoxalidines as described in U. S. Patent Re. 23,227,[2] and acylated amino alcohols of the type described in U. S. Patent 2,589,195[3] is very effective in controlling scale and corrosion in cooling tower water.

A more complete description of the compounds in U. S. Patent Re 23,227 is related as high molecular-weight, semi-polar heterocyclic compounds, consisting largely of substituted glyoxalidines or mixtures of substituted glyoxalidines containing a rather large hydrocarbon radical. The material is marketed as a proprietary compound known as "Kontol."

The subject matter of U. S. Patent 2,589,195 is acylated amino alcohols in which the acyl group is derived from detergent-forming acids and more generally described as a mixture of fatty acids and hydroxy alkyl amines. It is marketed as a proprietary compound known as "SP-8."

When the above described compounds are mixed together they exert a synergistic action; that is, neither material when used alone will provide complete control of scale and corrosion in cooling water systems.

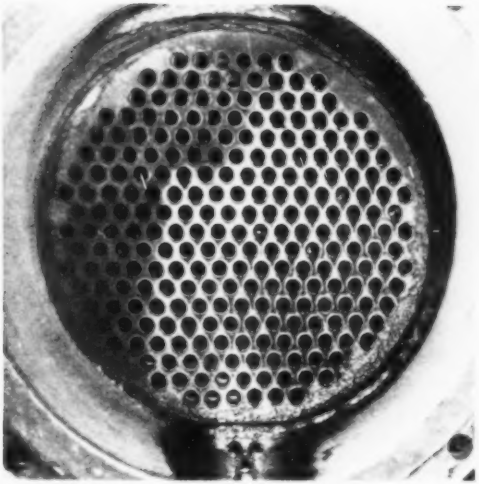
The laboratory data in Table I are offered to show the synergistic action.

It is observed in Series I and in Series II at 50 ppm. concentration,

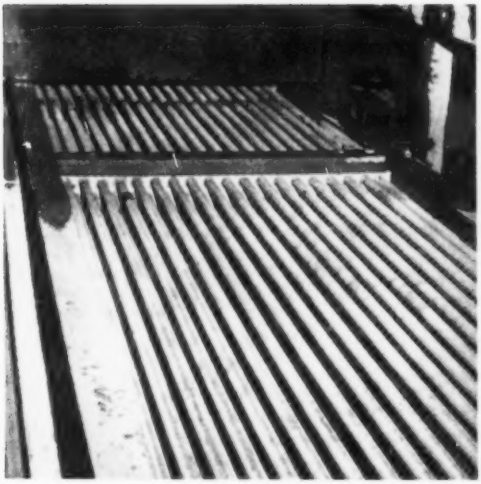
Table 1—Synergistic Action of Organic Corrosion Inhibitors

Series I		Series II		Series III		Series IV		Series V		Series VI	
120 in tap water, pH 8.2		SP 8 in tap water, pH 8.2		120 & SP 8 water, pH 7		118 in tap water, pH 8.2		118 & SP 8 water, pH 8.2		118 in tap water, 120°F.	
conc. ppm.	pen. MPY	conc. ppm.	pen. MPY	conc. ppm.	pen. MPY	conc. ppm.	pen. MPY	conc. ppm.	pen. MPY	conc. ppm.	pen. MPY
0	29.8	0	29.8	0	42.2	0	25.8	0	25.8	0	82.5
10	25.4	50	17.6	12.5	41.8	12.5	14.0	25	3.8	17	24.8
20	18.8	100	3.8	40	16.9	25	3.8	50	1.1	35	22.2
30	13.2	200	2.0			50	0.8	100	0.8	160	0.4
40	11.8					100	0.4	200	0.4		
50	9.2										

* This article was presented originally by invitation under the title "Use of Surface Active Agents in Cooling Tower Water Treatment" at the 3rd annual Southern District meeting of American Petroleum Institute held in Houston, Texas, on Dec. 7, 1951.



22 MONTHS AND STILL CLEAN: an engine jacket water cooler in one plant



12 MONTHS AND ALSO CLEAN: an atmospheric cooling section at another plant

corrosion rates in Kontol 120 alone are to the order of 15.2 MPY (mils per year) and in SP-8 alone at 50 ppm. concentration 47.0 MPY. In Series III at 40 ppm., each Kontol and SP-8 mixture provides a lesser corrosion rate at a smaller concentration than 50 ppm. It will also be noticed in Series V that Kontol 116 and SP-8 at 50 ppm. concentration each presents MPY value of 1.1. The only difference between Kontol 116 and Kontol 120 is the degree of water solubility.

Earlier data is best presented by means of the graph, Fig. 1. Curve 1 represents the weight loss curve of soft iron in circulating aerated tap water. Curve 3 represents the weight loss curve in tap water containing 1:75000 Kontol 120 and 1:75000 SP-8. Note that these curves are very close together, showing that within the limitations of the laboratory test the Kontol 120 and SP-8 had negligible effect on the corrosion rate.

However, when the test strips are pre-treated with a more concentrated solution of the two chemicals (about 1:1000 for 5 days), Curve 2 is obtained in tap water, showing a very low weight loss and fairly constant slope for about twelve days. In Curve 4 the pre-treated test strips are in the 1:75000 concentration of Kontol 120 and SP-8.

As mentioned before the principal problem in treating cooling tower water is the prevention of heat insulating scale and corrosion of the metal piping involved in a cooling tower water system. A secondary requirement is the prevention of delignification of the wood cooling tower. It is believed that SP-8 and Kontol are also effective in controlling cooling tower delignification.

The proposed explanation of the behavior of SP-8 and Kontol in regard to wood delignification is as follows: The lignin portion of wood contains a multiplicity of carboxyl groups and these anionic groups would tend to react with SP-8 and form a surface molecule. They might also be expected to react to a considerable extent with Kontol compounds and in both cases would thereby yield a surface of hydrocarbon groups which would interfere with the attack of alkaline solutions on the lignin.[3]

One of the primary reasons that this treatment is especially effective over and above the conventional treatments is indicated by the cost data below. For instance, one gasoline plant, designated as Plant "A", using conventional chemical treatment:

Chemical	Amount	Cost
Hexametaphosphate	16 2/3 lbs./day	$2.66
Sodium Chromate	8 lbs./day	1.20
Sulfuric Acid	66 2/3 lbs./day	1.00
Chlorine Gas	15 lbs./day/week	0.25
Total cost per day		$5.11

Treating costs were to the order of $5.11/day and there is evidence supported by photographs that this system-polyphosphate, chromate, sulfuric acid feed—was not entirely satisfactory inasmuch as corrosion was prevalent, as shown in the pictures. By utilizing a mixture of Kontol and SP-8 for both scale and corrosion control, it was found that treating costs might be reduced to $0.37½/day. The concentration of SP-8 and Kontol used ranged from 1 to 1,000 (1000 ppm.) to 1 to 75,000 (13 ppm.). The material was an effective corrosion inhibitor in all of these ranges, and the following are the results of a two-week coupon exposure in the cooling tower water system of Plant "A". The coupon showed no pitting and the following data are reported:

Exposure Period	14 days
Weight loss, gms.	0.05
Weight loss, gms./sq. ft./yr.	2.04
Penetration, IPY (inches/yr.)	0.0035

A water analysis of the make-up and the circulating cooling tower water is shown in Table 2.

Table 2—Water Analysis, Plant "A"

Orig. water	Constituent	Make-up water
ppm.		ppm.
479	Sodium	1001
65	Calcium	24
10	Magnesium	94
0	Sulfates	0
1200	Chlorides	1210
0	Carbonates	264
615	Bicarbonates	926
11.4	Silica	32
0	Fe & Al oxides	0

It should be noted that the water is concentrated approximately 3½ times. Relative calcium and magnesium contents in the water should be about 260 ppm. calcium and 120 ppm. magnesium. Actually the values are 24 ppm. calcium and 94 ppm. magnesium. This indicates that a substantial amount of calcium and magnesium carbonate is being precipitated. Apparently the deposits are remaining dispersed in the water and being discharged by tower blow down and practically no scaling was present in the system.

As with all shell and tube heat exchanger operations, some probing will be necessary. For instance, when a piece of scale or foreign material flakes off, it is deposited on the inlet side of the heat exchanger tubes, thus decreasing water velocity.

According to some authorities scale is formed directly on the surface of this confining equipment, particularly if the latter is hot, while other authorities are of the opinion that insoluble salts separate at varying distances

from the surface and adhere upon contact. The author is more inclined to agree with the latter theory, since it more nearly expresses the effect of SP-8-Kontol treatment in preventing the adherence of scale forming solids to confining surfaces. If and when a "sludge" does develop as a result of decreased water velocity, causing the insoluble salts to precipitate, the sludge thus formed is loose and soft in character and can be washed out rather than bored out. The SP-8-Kontol treatment has been used satisfactorily in the cooling tower water system of three compressor plants. Two of the plants utilized conventional shell and tube heat exchangers while the third used open type atmospheric sections of the cooling tower.

The material was field tested in an effort to mitigate corrosion in a gasoline plant cooling tower water system in West Texas. The Kontol-SP-8 treatment provided protection only under certain conditions, and apparently was not satisfactory under the conditions in which it was used. Therefore, its use was discontinued in this plant. Although it was at first thought that this failure might be due to excess sulfate ion in the water, control tests show that sulfate ion has no effect on the protection offered by these compounds. It must be concluded that something extraordinary is present in the cooling tower water such as naturally occurring organic compounds or trace ions to promote a pitting type attack. It is also believed that perhaps an insufficient amount of the SP-8-Kontol mixture was used. It has been found by laboratory tests that an insufficient amount of polar type organic inhibitor does induce severe pitting attack.

In all cases the water is recirculated and is concentrated 3½ to 5 times.

Other than the economic value, this type of treatment has a further advantage in that no daily chemical testing of the water is necessary, thus releasing an operator for more important jobs. An additional advantage is provided inasmuch as the tower blow-down water contains no poisonous matters, and the disposal of poisonous waste waters containing chromate is always a problem.

Theory of operation of the treatment at present can only be surmised. A rationale for the mechanism of the use of Kontol in preventing corrosion is presented:

It is believed that these inhibitors function by forming a tightly adherent adsorbed film on metal surfaces, a film which is perhaps only one molecule thick or at most only a few molecules thick. The forces responsible for the adsorption of the molecule on the metal surface are not well understood but are probably a combination of van der Waals forces and those forces responsible for chemical union such as electron-pair bonds. Indications are that the hydrocarbon portion of the molecules is oriented outward and these hydrocarbon radicals are probably sufficiently closely packed to create a barrier to migration of molecules of corroding agent through the film.[5]

The action of SP-8 in scale prevention at present can only be surmised. It is assumed that scales do not grow on metal surfaces in smooth sheets, but rather from centers of activity. The surface activity of the inhibitor is sufficient to enter the cracks and crevices in the scale and dislodge the scale by spalling from the metal surface. It then appears to preferentially coat the metal surface with a film. A good explanation of the surface activity involved would necessitate an extensive excursion into a rather complicated physical chemistry which would require much more of a discussion.

It is believed admittedly based on insufficient evidence, that the SP-8 probably functions by interfering with the growth of crystals of calcium carbonate and or sulfate which normally form an adherent scale. The compound forms a high molecular weight cation, to the extent that it is ionized, which might be attracted to the carbonate or sulfate ion in the surface of a microcrystal. Since this organic ion would be very large compared to the normal calcium ion occurring in the crystal, it would thus create an irregularity in the surface of the crystal and greatly hinder its growth to a larger size. This organic radical would also probably offer much less chance for adhesion to metal surfaces and would thus decrease the tendency for the microcrystal to form an adherent precipitate. Further, its small size would favor its being carried along in the circulating water system.

There is no ready explanation or rationale to cover the synergistic effect observed between the two materials in lowering corrosion. It might be supposed that if the SP-8 compounds have a strong tendency to combine with anions, as pictured when it adsorbs on a microcrystal of carbonate, it might combine with hydroxyl ions to form a high molecular weight amine at or near the cathodic areas of the corrosion cell where the hydroxyl ion concentration is high. This free amine might be relatively insoluble in high alkalinities and might thus tend to blanket and interfere with the behavior of the cathode. This effect, combined with a pictured general adsorption of Kontol, might cooperate to give a low rate of corrosion.[5]

The data thus presented and the testing results are still considered by the author as being in the pilot plant stage. Out of four plant runs, one gave results which, while showing some improvement, would not be considered commercially satisfactory. Certainly these results do not affect in any way the value and usefulness of the proposed method. This means that the theory and suggested operational technique of the use of surface active agents in scale and corrosion control in cooling tower water could be refined and improved. The author is fully aware that further studies are required in this field and it is hoped that this report will stimulate additional activity in the search of the presently available surface active agents and their use in scale and corrosion control.

Acknowledgment

The author wishes to express his appreciation to Sun Oil Co., Gulf Coast Div., for their permission to publish this paper, and also to Mr. E. J. Simmons and Mr. Morris Bock of the Sun Oil Co., Dallas Division Laboratory for their splendid assistance in performing the laboratory work connected with this test.

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(1) Schmidt, Frank: "Water Treatment" (46) 210-212.
(2) U. S. Patent No. 2,5[illegible]27.
(3) U. S. Patent 2,561,166.
(4) Personal communication: C. M. Bean to W. F. Oxford, Jr.
(5) [illegible]

Meet the Author

W. F. Oxford, Jr., head of the corrosion and water treating section, Sun Oil Co., Gulf Coast Division Production Laboratory, Beaumont, Texas, was graduated from Texas A & M College, where he specialized in chemistry and physics. Following graduation he taught at the same college in the chemistry department, and did graduate work.

In his association with Sun, Mr. Oxford is engaged in oil and gas-condensate well corrosion problems as well as salt water disposal studies.

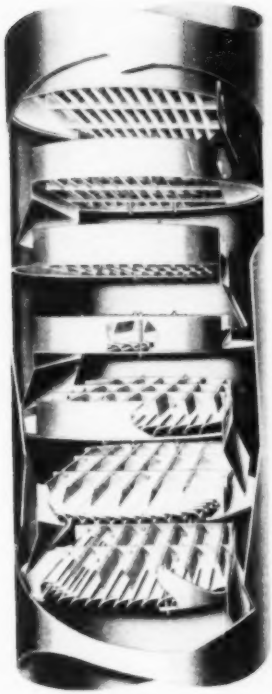


FIG. 1—NEW BENTURI-TYPE Kaskade trays installed in a column

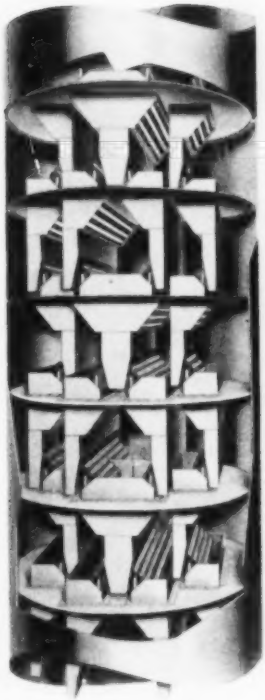


FIG. 2 — OLD KASKADE trays as originally developed 10 years ago

HOW IT WORKS, WHAT IT DOES

The New 'Benturi' Fractionator Tray

By D. P. THORNTON, Jr.
Southwestern Editor

SOMETHING new has been developed in fractionator tray design.

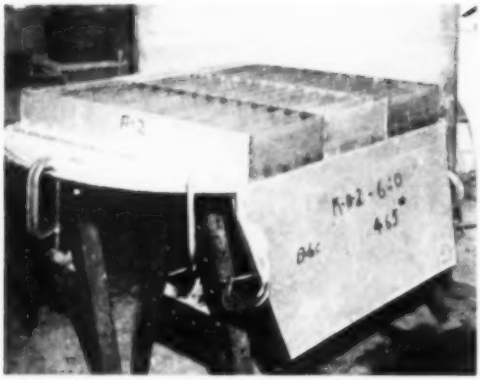
It is called the "Benturi-type Kaskade tray" and has been worked out by the Koch Engineering Co. of Wichita, Kans. Essentially, it consists of a number of curved vapor passages delivering ascending vapors horizontally into the tray liquid. Above these slotted passages are a series of slanted baffles, perforated with ¼-in. or ⅝-in. holes, triangularly pitched on ⅝-in. or ¾-in. centers. A cut-away drawing of the tray and column arrangement is shown in Fig. 1.

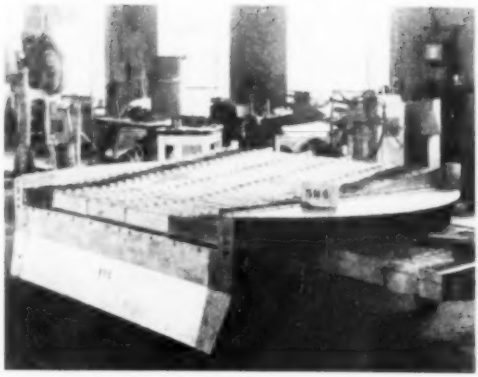
The new design is based on the earlier "Kaskade" tray brought out by Koch about 10 years ago. It permits vapor velocities exceeding the maximum permissible under the well-known Brown and Souders equation[1] in almost every application tried to date. Rates exceeding 160% of Brown and Souders now are commonly applied in commercial design, while rates ranging from 180 to 200% have proven successful in many jobs.

This translates to several practical advantages in chemical plant, refinery and natural gasoline plant operations. Among them are:

1. Tower sizes will be smaller, both in diameter and height, compared to conventional bubble trays having identical throughput;
2. Pressure drop will approximate half that of the bubble deck;
3. As replacements for bubble decks in existing towers, throughput may be increased 30% or more in distillation, 50 to 100% in absorption and stripping, and equivalencies of 2 to 2.8 theoretical stages—efficiency per tray 35 to 46.6%—in liquid-liquid extraction (based on pilot plant data for a 6-tray column with the system furfural-cyclohexane-water);
4. Probable reduced maintenance requirements, and
5. Trays are light-weight, require a minimum of materials, and usually can be designed to utilize existing supports and downcomers in replacement jobs.

Applications for which the new trays already have been installed include: *chemical plants*, butanol stripping, solvent recovery, liquid-liquid extraction, distillation and purification operations in vitamin and penicillin production, and other chemical separations; *refining*, crude distillation, light ends fractionation, close-cut naphtha fractionation, amine desulfurization (contactor and regen-





FIGS. 3-4—TYPICAL TRAYS of the new Benturi-type design, under fabrication in Koch's shops. **Fig. 3** (left)—Upper tray for 6-ft. 15-tray crude distillation tower to replace bubble tray. **Fig. 4** (right)—Tray for 11-ft. crude distillation column; note "slant" of tray from horizontal

erator) and stripping operations, and *natural gasoline plants*, absorption, LPG recovery, sweetening operations.

The Kaskade Principle

The new tray was first applied commercially late in 1950, and publicly announced about a year later without details. The similarity to the earlier "Kaskade" tray developed by Koch in 1942 will be apparent by comparison with Fig. 2. The early form was developed especially to meet the need for a tray capable of handling high loadings at greater tray efficiencies than were then being achieved with bubble-decks. It also was desirable to retain operating flexibility and, if possible, minimize entrainment and mal-distribution problems. A further desirable improvement was more efficient contact between vapor and liquid without materially increasing pressure drop.

As arranged, the early Kaskade tray (Fig. 2) in effect splits the upcoming light vapor, or liquid, into a series of uniformly distributed streams, each intimately contacting every increment of liquid in the same manner and for the same period of time while the liquid is enroute from downcomer.

With bubble caps, the high liquid gradient on the tray inlet side tends to reduce or retard the flow of vapor through the liquid and, at the same time, increases vapor flow rate on the outlet side. In extreme cases liquid may actually flow backward, through the bubble-cap risers on the liquid inlet side, while at the liquid outlet side the liquid may be nearly blown off the tray due to the high vapor velocities created. Under such conditions entrainment is great and vapor-liquid contact very poor; a "puke" is imminent. Pressure drop is inherently high in the bubble-tray, due to the tortuous path required of the rising vapor in achieving liquid contact, while losses analogous to those experienced with orifices occur as vapor passes through the slotted caps.

The original Kaskade design materially increased the slot and downcomer areas as well as weir length in comparison with the bubble-tray. Increasing slot area reduced vapor velocity at any given throughput and with it the losses measured as pressure drop. Increased downcomer area also reduced liquid downflow velocity. Greater weir length moved the liquid volume over a greater area, making for improved contact with vapor—i.e., each of the perforated baffles constitutes a weir. The perforations also improved vapor-liquid contacting.

The greatest contributing factor to higher net throughputs, however, was more efficient use of tray area. The "dead spots" represented by the area of the bubble-cap itself, constituting a large portion of the total tray area, were for the most part eliminated.

However, the original Kaskade design by no means solved all distillation problems. For instance, where vapor load was very high in comparison with liquid—or the analogy in absorption where vapor volume is much higher than that of the absorbent—there was definite room for improvement. There was too much weir length and downcomer area, not enough vapor capacity.

Streamlining of the vapor slots, careful study indicated, would reduce pressure drop without sacrificing available liquid mixing energy, a particular advantage in vacuum distillation. Reduction in baffle area was desirable to make for reduced surface area requiring cleaning and susceptible to being coated or plugged with solid matter. It was found that the scouring action kept the lower sections of the perforated baffles clean for long periods in "dirty" service.

It was further evident that tray efficiency could be improved, especially where liquid volume was especially low in comparison to the vapor load. Column height could be reduced by the flat design with shorter baffles.

Table 1—Comparison of Kaskade with Bubble Trays in High Pressure Absorption

	Inlet Gas Both Towers Mol %	Residue Gas, Mol %		Moles Absorbed* Per Hour from Gas		Percent Absorbed	
		Bubble Trays	Kaskade Trays	Bubble Trays	Kaskade Trays	Bubble Trays	Kaskade Trays
CO_2	0.600	0.20	0.40				
C_1	87.000	95.60	94.90	520.00	124.00	12.4	12.4
C_2	7.000	3.33	3.51	33.20	33.20	24.4	26.6
C_3	3.400	1.16	0.71	12.20	20.10	26.6	23.6
C_4	1.000	0.04	0.11	7.10	8.00	65.0	71.5
C_5	0.500			4.50	4.50	100.0	100.0
C_6	0.200			1.80	1.80	100.0	100.0
C_7	0.100			0.90	0.90	100.0	100.0
C_8	0.100			0.90	0.90	100.0	100.0
C_9	0.100			0.90	0.90	100.0	100.0
Total	100.00	100.36	100.36	587.50	194.30		

* From feed at assumed

** Calculated from residue gas compositions and gravities

thus bringing the trays closer together.

Venturi Shape Used

In the Benturi development of Fig. 1, recourse was taken to the well-known characteristic of the venturi. (The new name actually is a contraction of the term "bent venturi," which sounds like "benturi" when spoken rapidly.) As is well-known, between 80 and 90% of the energy of the vapor passing through a venturi can be recovered and used largely in mixing the vapor-liquid mass. Low pressure drop thus is an inherent characteristic.

The design is flexible. In all cases the slot can be still further reduced in favor of increased downcomer area for applications where liquid load is high compared to the vapor (but at some decrease in pressure drop). The liquid cannot possibly flow down through the risers, short-circuiting the tray. Liquid head across the tray is held uniform, regardless of density and viscosity, by a combination of slanting the tray down from horizontal along with appropriate adjustments in baffle density (size and spacing of perforations and number of baffles).

Instead of the original S-shaped entry utilized to direct vapor horizontally into the liquid, a bent venturi is used as the riser. The upcoming vapor therefore makes a single 90° turn instead of 180° as in the original development and 270° for the bubble-cap. A violent frothing occurs instead in and between the perforated baffles, assuring that the liquid is well-beaten with vapor, and a jet action develops to move liquid froth across the tray rather than dependence solely on the effect of an hydraulic gradient.

Increasing downcomer area has two practical advantages, since it has not been necessary to increase the length (tray spacing requirement for a given job has not increased). First, there is less resistance to flow. Second, it can be designed to provide sufficient residence time between trays to permit proper settling action. This reduces vapor entrainment in liquid flowing to the next lower tray.

Not only has operating flexibility been increased in the Benturi for various types of loading but the aim of adapting it to low liquid—high vapor rate conditions has been achieved. In general it has been found in commercial installations that still higher loadings can be imposed than were possible with the original Kaskade tray, thus obsoleting the latter for most applications.

There is still another advantage of especial interest in refinery and chemical plant operations. Benturi tray holdup can be as low as 30% of that for a conventional bubble tray. Where polymerization or decomposition may be a factor in yields, quality of product or maintenance requirements, as a consequence of time and temperature, reduced tower holdup can greatly contribute to process economics.

This is primarily a problem in design arrangement of the tray, since the "standard" layout has an inherent holdup of around 40% that of the bubble tray. It develops from the fact that a lower density of liquid mass crosses the tray at all times, although the mean path of vapor through the liquid, being curved, equals and generally exceeds that for the bubble-cap.

Commercial Installations

There now are nearly 300 commercial installations employing either the Kaskade or its successor the Benturi-Kaskade. Many of these represent replacements of bubble-trays to achieve increased throughputs, either by wholesale replacement of tower internals or only trays in the overloaded portions of existing columns.

The two forms of the tray are shown in Figs. 3 and 4. Fig. 3 shows the upper tray of a 15-tray crude distillation tower, 6 ft-9 in. diameter, handling 9600 b/d of Midcontinent crude. The downcomer to the next tray below is at the right of the tray. Notice the use of vertical bolts

Table 2—Performance of Low Pressure Absorber

Component	Mol % Rich Gas	Mol % Lean Gas	Absorption: Mols/100 Mols Rich Gas	Absorption: Per cent on Feed
N_2	10.57	99.20	0	0
O_2	0.44	4.17	0	0
H_2	0.26	4.11	2.48	10.0
CH_4	1.00	0.26	0.93	74.8
C_2H_6	0.32	0.10	2.20	94.8
C_3H_8	0.14		0.93	100.0
C_4H_{10}	0.11		0.93	100.0
C_{5+}	2.87		2.93	100.0
	100.00	100.00	10.40	

Eleven Tray Absorber

	Theoretical Trays (Calc.)	% Efficiency	% Absorbed
C_3	5	45.5	40
C_4	5	45.5	25
nC_5	5	72.0	100

* Assuming no C_3 or C_4 is absorbed.

Table 3—Refinery Depropanizer Operation Before and After Installing Benturi-Type Kaskade Trays

Analysis	Depropanizer Charge* Before	Depropanizer Charge* After	Depropanizer Overhead Gas** Before	Depropanizer Overhead Gas** After	Stabilized Naphtha Distillate* Before	Stabilized Naphtha Distillate* After
Vol. %:						
N_2 + (?)				1.7		
O_2				0.3		
H_2			0.5			
CH_4			0.2	0.4		
C_2H_4			0.2			
C_2H_6			5.8	7.2		
C_3H_6			0.5			
C_3H_8			29.3	63.5		
Total C_4's (Cut	2.5	1.9				
iC_4		0.7	10.3	10.4		
nC_4		4.4	10.4	2.5	1.1	
C_5 paraffins	4.7					5.6
C_5 olefins	0.4		0.1			0.1
iC_5	2.5	4.7	0.3	0.3	3.5	4.6
nC_5	0.1	5.5		0.6	5.4	5.8
C_{6+}	84.1	82.8			89.3	83.0
H_2S		0.2	30.9	12.9		0.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
H_2S gm/100 scf	0.02#	0.17#			0.0014	0.0065

* Low temperature fractional distillation.
** Mass spectrometer.

Tests						
Gravity, °API	83.1	82.3			62.2	61.6
Vapor Pressure		9.6	1,573 (at 45.1	1,548 (at 45.1		0.4
Distillation (ASTM), °F						
IBP	102	84			110	100
5	124	126			148	148
10	132	134			160	154
20	176	176			178	176
30	194	194			194	196
40	207	214			206	212
50	220	228			218	226
60	231	242			230	240
70	243	256			240	252
80	256	272			254	270
90	273	294			270	289
95	289	310			282	304
E. P.	326	348			328	341
Res.	1.0	1.0			1.0	1.0
Yields, Vol. %	21.16*	27.40*	2.2	2.0**	26.56	26.70
					66.85	62.05
Rates, bbl./hr.	375	488	21,412 M cf/D	27,511 M cf/D	382	476

* Based on crude.
** Based on depropanizer charge.

Table 4—Efficiency Test of Kaskade Tray in Solvent Extraction

(System: furfural—5% water—cyclohexane—water)

Solvent Rate, gal. hr. per sq. ft.	Number of Theoretical Stages (Batch Extraction, single and multistage)	Per cent Efficiency
	Furfural dispersed; column upright	
1.0	3.2	29.1
1.4	3.4	25.4
1.9	3.4	23.3
2.6	3.4	
	Hydrocarbon dispersed; column inverted	
	Two-inch end sections	
1.0	2.3	39.9
1.4	2.3	34.3
1.9	2.3	30.6
2.6	2.3	

Tray Efficiencies
Hydrocarbon Dispersed
Column Inverted
(Average of two runs)

Tray Number	Efficiency % of 1 Stage
1 (Top)*	54
2	26
3	35
4	20
5	22
6	41
7 (Bottom)**	100

* Feed tray. ** Re-mixed gas passed to atmosphere at 99.5 % recovery of 2-ft. end section.

for easy assembly through tower manways. This column was re-trayed for greater throughput, making use of existing supports.

Fig. 4 shows a tray for an 11 ft.-0 in. crude-distillation column designed to handle 30,000 b.d. of distillate crude, taking 92° as overhead product. There are 16 trays on 30 in. spacing. Note the "slant" of the tray to hold uniform liquid head from inlet to downcomer at left.

Performance in Absorbers

Several cases of direct comparison between the Benturi-Kaskade trays and the conventional bubble tray are available. Table 1 presents the comparison for a high-pressure absorber in a large natural gasoline plant, for data having been taken by the plant staff.

In this load the two towers were paralleled on both incoming gas and lean oil streams, with approximately equal loadings on the two towers. They were identical except that one had been trayed with the Kaskade design and the other had all bubble decks. Both columns retained substantially all the n-butane and heavier components, but the Kaskade obviously retained more of the i-butane and propane than did the conventional tower.

In another test, the same two towers were run to ultimate capacity, the deciding factor being excessive entrainment of absorption oil. It was determined that the bubble tower capacity was at the rate of 13,000 Mcfd., representing a Brown & Souders vapor rate-factor of .521. The Kaskade-equipped tower, on the other hand, did not exhibit entrainment at the rate of 19,642 Mcfd., the maximum gas volume available to the plant, representing a Brown-Souders rate-factor of .787. It is estimated from test data that the probable capacity is approximately 21,500 Mcfd. Liquid loading under these conditions for both towers was 1142 gpm.

Table 2 shows the performance of a low-pressure absorber charging gas at a rate of 33,000 Mcfd. and 265 psia., with 500 gpm. of 52° API lean oil of 180 molecular weight. The absorber was 5 ft. diameter, temperature was 100° F. and Brown-Souders rate-factor was .590. Although this is not a comparative test against bubble tray design, the performance was as satisfactory as previously noted for a high-pressure design.

Table 3 illustrates the comparative performance of a depropanizer before and after the bottom 17 trays were replaced with Benturi-Kaskade type. The column is a part of the crude distillation unit of a large refinery and data were taken from plant records. Due to plant operating changes, it is not possible to compare performance on identical feeds. Otherwise results are self-explanatory.

Performance in Extraction

Table 4 illustrates the performance of a small, pilot model Kaskade extractor, fabricated by Koch for experimental investigations by its customers. In this case it was evaluated against single and multistage batch extractions for comparison, using the system furfural (plus 5% water)—cyclohexane-water.

With the column upright, that is, in the "normal" position with the curved slots pointing upwards and furfural dispersed, the extraction was slightly better than one theoretical stage over the whole tower. The tower then was physically inverted, since it is small, the hydrocarbon then becoming the dispersed phase. The extraction greatly improved, averaging well over two theoretical stages in six runs. In both tests, extraction improved with increasing solvent rate.

The reason for the improvement in the second case, with the column inverted, is that the hydrocarbon-water phase was moving across each tray while solvent entered through the slots. The net effect was to successively treat the hydrocarbon-water phase with small increments of solvent as it moved across each tray and up the tower. In the first case, the situation was exactly the reverse.

During two of the runs with the column inverted and hydrocarbon dispersed, efficiencies were determined for each of the six trays; the averages are reported in Table 4. A considerable effect was exerted by the 2-ft. end sections of the column which increased sharply the efficiencies for Trays 1 and 6. They acted as settling zones following the violent mixing which occurred with the solvent rate at 1.4 ft. per minute.

Sizing Towers

One of the problems facing the process engineer in designing a process is the size of the fractionator columns required for the job. Oftentimes he decides the permissible loading, but must rely on the equipment supplier to furnish final information as to column sizes required.

Fig. 6 is a chart showing the required column diameter for light oil fractionators at maximum design rates with 30-in. Benturi-type Kaskade tray spacing in the range 2 ft.-6 in. to 11 ft. tower diameter. It is intended that the process designer will use his customary methods for determining the vapor and liquid loadings for any given application—the usual information furnished to the equipment supplier for a quotation. The *K factor* used in the chart is determined by the formula:

Chart K factor $= CFS\sqrt{\dfrac{\text{vapor density}}{0.0755}}$

when, under column operating conditions, CFS = maximum vapor rate, cu. ft. per sec., and *Vapor density* = lbs. per cu. ft.

For tray spacings between 18 and 36 in., and other than 30 in., the following corrections should be used:

$$\text{Chart K factor} = \text{K factor} \times \sqrt{\frac{\text{K factor @ 30 in.}}{\text{30 in.}}} \times \sqrt{\text{desired tray spacing, in.}}$$

$$\text{Chart liquid rate} = \text{Liquid rate @ 30 in.} \times \left\{\frac{\text{30 in.}}{\text{desired tray spacing, in.}}\right\}$$

The chart has been constructed using the well-known Brown-Souders formula[3] for allowable maximum vapor velocity:

$$B.S. = C\sqrt{\frac{d_l - d_v}{d_v}}$$

where, at tower conditions of temperature and pressure,

d_l = density of liquid, lbs. per cu. ft.,

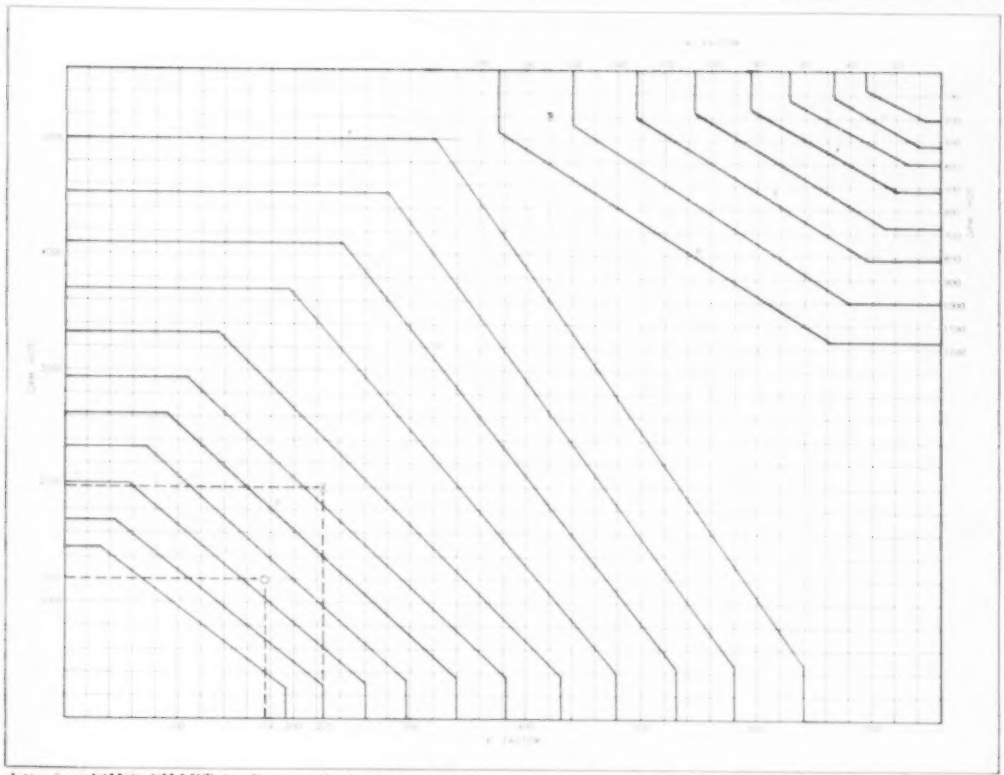


FIG. 5—SIZING CHART for Benturi-Kaskade trays on 30-in. spacing, from 2½ to 11 ft. diameters, in terms of maximum vapor and liquid loadings.

d_v = density of vapor, lbs. per cu. ft., and

C = a correction factor depending on: (1) tray spacing, (2) allowable entrainment without sacrificing product quality, (3) foaming characteristics of liquid (surface tension, etc.), and (4) liquid loading (a quantity), a factor recently introduced by most tray designers, generally based on experience.

However, considerable modifications have been introduced in developing the Koch chart, principally in values of C used for correction. These conform to the factors listed above, but are peculiar to the requirements of the Benturi-Kaskade tray. Therefore, it should be noted that the conventional Brown-Souders calculation, employing the usual values for C, is useless when using the Koch chart.

The following problem will illustrate the use of the Koch chart in determining column diameter for maximum loading. Given, 32.0 cu. ft. per sec. of vapor at density of 2.17 lbs. per cu. ft. under column conditions; maximum liquid load, also at tower conditions, 1200 gpm. Find the tower diameter required with 30 in. tray spacing.

Solution:

Chart K factor $= \dfrac{}{}$

$$32.0 \sqrt{2.17 \div 0.735} = 174.2$$

Enter chart with *K factor*, reading vertically to intersection with horizontal 1200 GPM (Hot) liquid line. This point is marked with a circle for reference in Fig. 5.

The next larger tower diameter is 7 ft.-6 in., representing minimum required diameter. In practice, considerable flexibility has been built into the chart by use of generous allowances. Depending on the nature of the materials handled and sharpness of fractionation required in a specific case, it might be possible, in the supplier's judgment, to furnish a smaller size. This is not a generalization, however, and the tower manufacturer should be allowed to check proposed duties against available designs before tower sizes are "frozen".

Suppose for further illustration 18 in. tray spacing is desired in the above problem. Recalculate the *chart K factor*.

K @ 18 in. $= 174.2 \sqrt{30 \div 18} = 225$

Recalculate chart liquid rate:

GPM @ 18 in. $= \dfrac{1200 \times 30}{18} = 2000$

Enter the chart with the new K, 225, and the new "Hot GPM", 2000, as was done previously. Tower size under the new conditions is 9 ft.-0 in., as shown on the chart for reference by the cross.

In order to compare the relative sizes of columns required for the Benturi-Kaskade and conventional bubble towers, the chart may be used for Kaskade sizing and the process engineer may use his usual time-tried procedure in sizing the requirement for bubble trays. Or, by reversing these steps he may determine the increase in load-handling capacity of the Kaskade tray by using his current tower size and determine the maximum permissible loading by "backing out" of the chart.

References

(1) M. Souders and G. G. Brown, *Industrial & Engineering Chemistry*, 26, 98 (1934).

(2) For description of this process see: C. W. Riggs, Jr., and H. J. Zandona, *Petroleum Processing*, Feb., '51, p. 136-7.

API Refining Division Committees Report on Their 1951 Activities

To acquaint the industry more widely with the important work being carried out by the various technical committees of the API Division of Refining, Petroleum Processing is again publishing these annual progress reports. They have been prepared for us by the committee chairmen, with the cooperation of W. T. Gunn, director of the Division, and his staff.

Refinery Equipment

Chairman: W. H. Creel
Phillips Petroleum Co.

THE Committee on Refinery Equipment has the responsibility of fostering the API program of standardization of refinery equipment and of formulating recommendations on engineering practice in the promotion of safety for the plant, worker, and general public.

As a matter of policy, the committee does not organize standardization projects in a given field except when no other authoritative agency is willing or able to undertake the particular problem or when such authoritative agency is unable to provide needed standards acceptable to the petroleum industry. When developing standards suitable for the petroleum industry, the committee cooperates with established agencies by naming representatives to serve on committees and working groups.

When there is no agency working in a given field, the committee organizes needed projects. When standardization is involved, the consultation and cooperation of the manufacturers of the equipment in question are enlisted.

Projects during 1951 were:

Study of the Design Construction, and Maintenance of Unfired Pressure Vessels. This study comes under the activities of the Subcommittee on Unfired Pressure Vessels, N. J. Reva, Chairman. The subcommittee serves as a forum for such problems and acts in an advisory capacity to the Joint API-ASME Committee on Unfired Pressure Vessels. It has helped in the final formulation of the rules in the 1951 edition of the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases (now off the press).

Study of the Design and Construction of Pressure-Relieving Systems—This study is being conducted by the Subcommittee on Pressure-Relieving Systems, J. C. Sonder, Chairman, with the active advice of the Manufacturers' Subcommittee on Safety and Relief Valves, L. P. Stillman, Chairman. Originally started in 1946 as a research project at the University of Michigan to gather and summarize engineering practice on the "design and construction of pressure-relieving systems in refineries," the subcommittee has crystallized these earlier data, as published in the University's Engineering Bulletin No. 31 (available at $3.00 per copy) with later modern developments and has almost completed a draft of a Recommended Practice for Pressure-Relieving Systems for Process Equipment and Storage Vessels.

Study of Corrosion of Refinery Equipment—This project comes under the Subcommittee on Corrosion, E. Q. Camp, Chairman. The subcommittee acts as a forum for the discussion of corrosion problems, guided through seventeen active panels, and sponsors technical presentations on the subject.

Study of Electrical Equipment—This project is under the Subcommittee on Electrical Equipment, L. M. Goldsmith, Chairman. The subcommittee is particularly reviewing the recommended practices for refinery installations of electrical equipment and its inspection, with the aim of referring its recommendations to the Subcommittee of Refinery Inspection Supervisors for approval as Part VI of the Recommended Practices for Refinery Inspections. The subcommittee also sponsors symposia on electrical distribution systems in refineries.

Study on Mechanical Equipment—This study is under the Subcommittee on Mechanical Equipment, E. F. Voss, Chairman. This subcommittee is working in cooperation with a Manufacturers' Subcommittee on Centrifugal Pumps, Lynn Sawyer, Chairman, to develop standards, where possible, for petroleum refinery pumps.

Study of Refinery Instrumentation. This project is handled by the Subcommittee on Instruments, G. N. Ehly, Chairman. The subcommittee has submitted a draft of a Recommended Practice for the Inspection of Control Instruments which is awaiting final approval by the Committee on Refinery Equipment, as Part V, Instruments, of the Recommended Practices for Refinery Inspections.

Study on Construction of Large, Low-Pressure Storage Tanks. This project is being developed by the Subcommittee on Low-Pressure Storage Tanks, W. L. Bowler, Chairman, and its Manufacturers' Subcommittee, H. C. Boardman, Chairman. These subcommittees are preparing a recommended practice for principles of design, construction, inspection, and the preparation of foundations, as far as the rules in existing standardized codes do not cover such vessels for pressures at 15 psi. or less.

Standardization of Refinery Valves. This project comes under the Subcommittee on Valves, R. H. Bungay, Chairman, and the Manufacturers' Subcommittee on Refinery Valves, W. P. Kliment, Chairman. The work of these committees has resulted in the combined API Standard 600 on Flanged and Welding-End Steel Wedge-Gate and Plug Valves for Refinery Use ($1.50 per copy).

Study on Inspection Procedures for Petroleum Refineries. This project is being conducted by the Subcommittee of Refinery Inspection Supervisors, J. H. Urian, Chairman. This subcommittee has been engaged in writing the Recommended Practices for Refinery Inspections, a manual for refinery operations' use, four parts of which are now available: Part I, Process Equipment; Part II, Pressure-Relieving Devices; Part III, Fire-Protection Equipment; Part IV, Low-Pressure Storage Tanks.

Study of Tank Accessories and Cleanouts. This project is under the Subcommittee on Tank Accessories and Cleanouts, E. E. Kerns, Chairman, and a Manufacturers' Subcommittee

on Tank Cleanouts, I. E. Roberg, Chairman. These subcommittees have prepared recommended rules for flush-type openings and proposed designs therefor which have been referred to the Committee on Standardization of Tanks for Oil Storage Tanks of the API Division of Production for consideration for inclusion in API Standard 12C, Specification for Welded Oil Storage Tanks.

Analytical Research

Chairman—E. L. Babbeschuetzer
Standard Oil Development Co.

THE purpose of the Committee on Analytical Research is to promote knowledge of analytical laboratory methods and techniques for use in solving analytical problems in petroleum laboratories.

The past year's activities of the Committee's various Subcommittees are summarized below.

The Subcommittee on Group Session Papers has organized a Group Session to be held at San Francisco on May 12 during the Midyear Meeting of the American Petroleum Institute. A total of thirteen papers will be presented covering topics of interest to analytical and refinery personnel. A similar session was held last year at Tulsa, Oklahoma.

The Subcommittee on Determination of Nitrogen has concluded cooperative work on four different techniques and will present a report at the forthcoming Group Session in San Francisco.

The Subcommittee on Analysis of Oxygenated Compounds has continued cooperative work on three modifications of the Unterzaucher procedure for the direct determination of oxygen in organic compounds. This work has shown that the presence of 0.02% of oxygen in a hydrocarbon mixture can be determined.

The Subcommittee on Trace Elements in Crude Oils and Catalytic Charge Stocks has continued its investigations in an attempt to develop a procedure for the complete recovery (from an analytical viewpoint) of metallic elements present in crude oils. Three techniques are being studied.

The Subcommittee on Emission Spectroscopy presented a report at the Tulsa Group Session covering an investigation of the Calkins and White dipped electrode procedure. The name of this Subcommittee has since been changed to Subcommittee on Cracking Catalysts. Its present function is the investigation of analytical methods for the determination of metallic impurities in cracking catalysts.

The Subcommittee on Determination of Sulfur and Sulfur types held its organization meeting last year. Three subgroups were formed to study (1) the determination of sulfur types, (2) the determination of elemental sulfur and (3) the determination of carbonyl sulfide in liquefied petroleum gases.

The Subcommittee on Refinery Effluent Water Analytical Methods had recommended a procedure for the determination of oil in effluent waters. This method has been adopted by the Committee on Disposal of Refinery Wastes. Work on another method is being continued also on the determination of phenols in refinery effluent waters.

A new Subcommittee on Analytical Methods for Atmosphere is being organized and will hold its first meeting this year in San Francisco.

Training

Chairman—T. M. Rushing
The Texas Co.

DURING 1951, the Committee on Training continued to serve as a forum for the discussion of training problems and techniques, vigorously prosecuted the advancement of its projects looking toward the improvement of training services available to the industry, and attempted to provide the industry with all information concerning developments in industrial training which are particularly significant.

At the Seventeenth Midyear Meeting, Dean S. Turner, chairman of the Committee's Subcommittee on Training Literature, will announce plans for the establishment of a training materials section in the API library. This announcement marks the successful accomplishment of phase one of a project which was begun more than two years ago. It also marks the beginning of the second phase of this project, which will consist of continued committee work to build up a first-class reference library devoted to training in refining.

The Committee will also receive a report of progress from its subcommittee engaged in developing a pattern of cooperation with the manufacturers of refinery equipment. The objective here is to improve and standardize installation and maintenance instructions for refinery equipment in order that these instructions will be more useful in training maintenance personnel without detracting from their value and usefulness to engineers and other technical personnel. This Subcommittee, chairmanned by J. J. Stadtherr, has been assured of the cooperation of the manufacturers of refinery pumps in the development of mutually satisfactory standards for pump maintenance manuals. The Subcommittee is convinced that the pattern which is being developed in this pilot operation with pump manufacturers can be readily adapted for other types of refinery equipment instruction manuals and believes the successful completion of this project will pave the way for extensive improvements in the field of training literature.

The Committee sponsored a group session at the Sixteenth Midyear Meeting, at which three outstanding papers were presented. Each paper dealt with some phase of the problems encountered by the refining industry in training its technical men. The committee is sponsoring a group session at the San Francisco meeting. Three papers will be presented, each dealing with some phase of the problem of communications in industrial organizations.

During 1951, the committee conducted a number of forums to discuss problems and subjects which were of mutual interest to its members. High-lighting these discussions were the following: Selection of Supervisors: Some Criteria and Procedures; Elements of an Adequate Supervisory Program; The Role of Management in Molding Employe Attitudes. Two subjects of general interest have been scheduled for discussion at the San Francisco meeting. They are: "Coaching—A Potential Management Development Tool," and "Communications."

The committee has one active area Subcommittee in the Gulf Coast. This district committee has a membership of approximately 25 training super-

visors who meet twice each year for the exchange of information and experiences concerning refinery training. Approximately 30 oil refining companies and more than 75% of the nation's refining capacity are represented on the Committee on Training.

Automotive Research

Chairman—John T. McCoy
Tide Water Associated Oil Co.

THE Automotive Research Committee sponsors investigations to promote the most effective use of automotive fuels and lubricants. The committee also acts as a forum for discussion of industry problems in this field. It is sponsoring a group session which will be held at the Seventeenth Mid-Year Meeting of the Division of Refining in San Francisco on May 13, 1952.

In cooperation with the U. S. Bureau of Mines, a number of fuel surveys are issued annually. The API arranges for the industry to contribute data, which are tabulated and analyzed by the Bureau. Reports have been made available to the public on characteristics of motor gasolines, diesel fuels, aviation gasolines, and jet fuels.

Another activity, which has been resumed recently, is conducting surveys of automotive equipment from the standpoint of requirements of petroleum products. A new sub-committee now is carrying out a project to solicit data from the industry on vapor locking tendencies of automobiles, and to analyze these data.

Research projects of interest to the Automotive Research Committee generally are conducted by the Coordinating Research Council, a non-profit organization sponsored jointly by the petroleum and automotive industries. The Automotive Research Committee formulates recommendations for API support of CRC and its projects, and the chairman of the committee serves as a member of the CRC Assignment Committee, which reviews projects before they are undertaken.

Currently, about two-thirds of the work of the Coordinating Research Council is carried out on military projects, either initiated by the Armed Forces or supported in part by them. Typical projects include research on the fundamentals of detonation by high speed photography, surveys of octane requirements of cars and trucks, development of road test techniques for evaluation of fuels, performance of railroad diesel fuels, low temperature pumpability of jet fuels, combustion characteristics of jet fuels, study of engine deposits, and study of aircraft lubrication.

Petroleum Products

Chairman—Albert E. Miller
Sinclair Refining Co.

THE scope of the Committee on Petroleum Products embraces the field of measurement, sampling and testing petroleum and petroleum products.

The Committee formulates recommendations concerning industry support of research projects having to do with the properties of petroleum and its products.

With the Committee resides the function of seeing to the maintenance of the Secretariat of ASTM Committee D-2 on Petroleum Products and Lubricants. Committee D-2 is the authoritative program of the users and producers of petroleum products for the development of methods of test and specifications. The Committee on Petroleum Products does not participate in the program of Committee D-2, although many members of the Committee on Petroleum Products are also members of Committee D-2, but limits its function to seeing to it that the facilities for adequate secretarial service are provided. The Committee has initiated recommendations for industry support of research projects defined by Committee D-2. Two such projects are underway at the present time.

One project is the maintenance of a Fellowship at Northwestern University on Vapor Pressure-Temperature relationships. The purpose of the study is the development of correlations for use in conducting a vacuum distillation test. A corollary development of more importance than the main objective will be the development of an improved Cox Chart.

Another study fostered by the Committee found that normal changes in barometric pressure reduce the accuracy of octane determinations. Inaccuracy in octane determinations could mean waste of critical supplies of TEL. Following the study a grant was made to ASTM to develop equipment to improve the accuracy of the test. Improved accuracy of testing benefits both consumers and producers.

The Committee fostered another grant to assist in the calculation of new volume correction tables for petroleum oils. The new tables will extend the range of the tables that appear in Circular C 410 "National Standard Petroleum Oil Tables" published by the National Bureau of Standards to include both lighter and heavier materials than are covered by the present tables. The new tables will be published by ASTM rather than by the government. The Natural Gasoline Association of America also made a grant to ASTM to assist in the preparation of the tables.

A continuing activity of the Committee is the distribution of oil standards for the calibration of viscometers; three oils are available at nominal cost to anyone interested.

The Committee has a number of subcommittees, each working on a project of interest to the industry.

Disposal of Refinery Waste

Chairman—E. N. Giles
Standard Oil Co. (Ind.)

THE Committee on Disposal of Refinery Wastes collects and publishes in manual form technical information which will be of assistance to refiners in the efficient handling and disposal of waste materials. During 1950 a program was undertaken

to revise Volumes I, II and III of the API Manual on Disposal of Refinery Wastes. This revision was for the purpose of including new information on waste disposal and also permitted segregating the analytical techniques for water and air contaminants into two new Volumes, IV and V. This work will be largely completed in 1952. Status of preparation of the new Manual is as follows:

Volume I, "Waste Water Containing Oil," is expected to be published by late summer of 1952. Chapter 2 will embody the results of the University of Wisconsin research project on the hydraulic behavior of gravity-type oil-water separators. This project, which was carried out during 1950-51, was directed by the Subcommittee on Oil-Water Separation and financed by the refining industry for the purpose of acquiring fundamental information on oil-water separators which could not be obtained from the literature or from pooling common experience.

Volume II, "Waste Gases and Particulate Matter," has just been published.

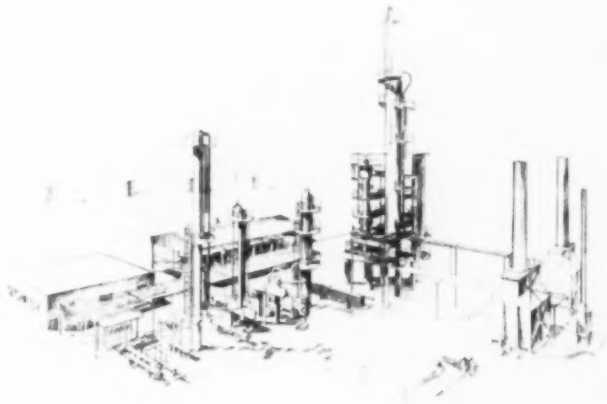
Volume III, "Chemical Wastes," was issued in August, 1951. A supplementary section, dealing with the biological oxidation method for treating refinery waste waters, is being prepared.

Volume IV, "Sampling and Testing of Liquid Wastes," and Volume V, "Sampling and Testing of Waste Gases and Particulate Matter," are currently being readied for early publication.

During 1951 a survey was made of current waste disposal problems facing the industry. As a result of this study, attention is being given to the following projects: (1) Development of a refinery flare which will have smokeless operation over a wide range of loading and will be of reasonable cost, safe to operate and fully reliable; (2) the evaluation of gas flotation as a method of removing oil from waste waters; and (3) the investigation of economical methods for handling and disposing of oily sludges and clays.

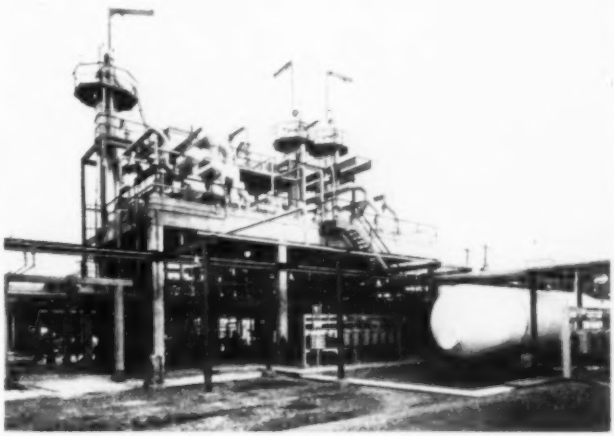
At the September 9-11, 1951 meeting of the Committee at Denver, a panel discussion was held on the subject of biological treatment of refinery waste waters. Several papers were presented which dealt with (1) the general aspects of the biological oxidation method as applied to the treating of refinery wastes; (2) the results of bench-scale, pilot plant, and plant operations with trickling filters; and (3) general design considerations for plant installations.

At the 1952 Midyear Meeting of the API Division of Refining, a Group Session on Waste Disposal will be devoted to the general subject of atmospheric gaseous wastes.



FLUID HYDROFORMER NO. 1 This is what it will look like when completed next August at the Destrehan, La., refinery of Pan-Am Southern Co. Construction on the 2,000 b/d unit was begun last month by the contractor—M. W. Kellogg Co.

The main group of vessels in the center of the drawing is the reaction-regeneration section. The reactor is the largest vessel in the group. Atop it is the spent catalyst stripper. To the left of the reactor is the regenerator, while behind it stands the catalyst storage drum. The unit's other principal components (L to R) are: control house, compressor house, three recovery towers (main fractionator, absorber, and stabilizer), reaction-regeneration section, naphtha furnace, recycle gas furnace, and blowback air heater.



ETHANOLAMINE NO. 3 Early in March Jefferson Chemical Co. put this new unit into operation at its Pt. Neches, Texas, petrochemical plant for the production of monoethanolamine, diethanolamine, and triethanolamine—thus becoming the third U. S. producer of these chemicals. Jefferson's two competitors are Dow Chemical and Carbide and Carbon.

The Lubrication of Electric Motors

- Kinds of bearings—sleeve, ball and roller
- How they are installed and lubricated
- How they are cleaned and flushed properly
- How to handle gear reduction motors

By ALLEN F. BREWER
Technical & Research Division
The Texas Co.

ELECTRIC motor builders have done a remarkable job of perfecting the design of a machine which operates probably under more severe conditions, more frequently, than any other piece of machinery.

Not too long ago use of electric motor power in some types of service was approached cautiously where arcing might cause explosions, or where the motor might have to run deluged with water. The explosion-proof motor changed all this. Today engineers take a practical view of maintenance as related to their motor power. They regard motor lubrication in a similar manner, realizing fully that dependable lubrication has a definite relation to motor life.

The service dictates the application and the type of motor that should be used. Windage is increased by high speed. Windage can cause abrasive dust to be pulled through both the bearings and ventilating apertures. High shaft speed also places a severe load upon the lubricant in its protection of the bearings if high temperatures may prevail.

For high temperature service, the lubricant used must be highly resistant to oxidation and formation of gummy, resinous, or carbonaceous deposits. In sleeve-type bearings these would tend to accumulate in the oil grooves to interfere with proper circulation of the lubricant. In ball or roller bearings they would pack in the raceways or cages to interfere with the rolling of the parts.

The gear motor more recently has made it necessary to consider the possible effect of windage and dust contamination upon the gear lubricant. The gear motor is an especially valuable means of combining the driving and speed reducing elements in one compact housing which is designed effectively to withstand entry of contaminating foreign matter. It is advantageous where installation must be made in hazardous or cramped localities, where space is limited or where low driven shaft speeds are required.

The petroleum industry is particularly interested in trends in motor design and the desire of some motor builders to relieve the operators of all thought of lubrication especially when dealing with ball-bearings. Methods of refinement and compounding are continually developing more dependable greases; products strongly resistant to oxidation, separation and solubility, and free from corrosive alkalis or acids.

It is not justified, however, to place the entire burden on the lubricant. The combination of design, bearings and lubricant can only function under a so-called "life-time" period when the motor is installed under favorable operating conditions. Extremes of temperature, for example, could reduce the dependability of initial "life-time" lubrication and render renewal of lubricant a necessity.

Bearings which are adaptable to standard motor design promote easy installation and low-cost maintenance. Where a double shielded or sealed type of bearing may be necessary, if it can be installed with but little trouble, it should benefit all concerned. A proper installation always is appreciated by the lubrication engineer; then he is assured of better performance of his lubricants and relieved of the possibility of explaining failures which so often are due to causes other than faulty lubrication.

Plain or Sleeve Type Bearings

In the plain or sleeve-type motor bearing, study of lubricant characteristics, composition of bearing metals, and methods of lubrication is essential to effective bearing protection. This is assured by positive lubrication through continuous presence of the necessary amount of lubricant to furnish an adequate film, and suitable bearing construction to permit complete circulation of the lubricant throughout the clearance space which exists between the stationary and moving parts.

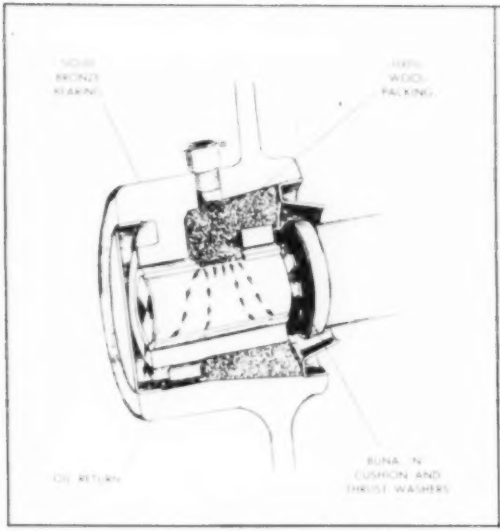
The theory of lubrication is based upon a definite relation between load, operating speed, bearing clearance, viscosity of the lubricant and point of oil application. When lubrication is effective and an adequate film is constantly maintained the bearing serves chiefly as a guide to insure alignment; in the event of failure of the lubricating film, however, the bearing must function as a safeguard to prevent actual damage to shafting or other parts of the machine. For this reason, sleeve-type bearing metal must be softer than any of the steels used for shafting or journal construction, and capable of wiping or even melting when in actual rubbing contact with the latter, to insure against scoring or cutting. It must be of sufficient hardness to carry the prevailing loads even at abnormally high temperatures, without wiping or becoming distorted, and yet the metal must be sufficiently plastic or ductile to conform to any irregularities on the surface of the shaft.

Two-part of split bearings are used in some types of heavy duty industrial motors. With this type of bearing the armature can be removed readily without disturbing the bearing assembly or the bearing can be removed without displacing the armature. Lower horse-power or fractional motors which employ sleeve-type bearings, however, are equipped with solid bronze or babbitt-lined shells.

Sleeve-type bearings designed for ring, wick or wool yarn oiling are most dependable when the motor is set horizontally on a level base. In wick oiling systems the wick touches the journal through a hole in the bottom of the bearing. Here flow of oil is upward by capillary action. Wool yarn systems lubricate by the same principle, but here a greater amount of material is used, oftentimes the yarn being in contact with the shaft over a considerable area and completely filling the bearing cavity.

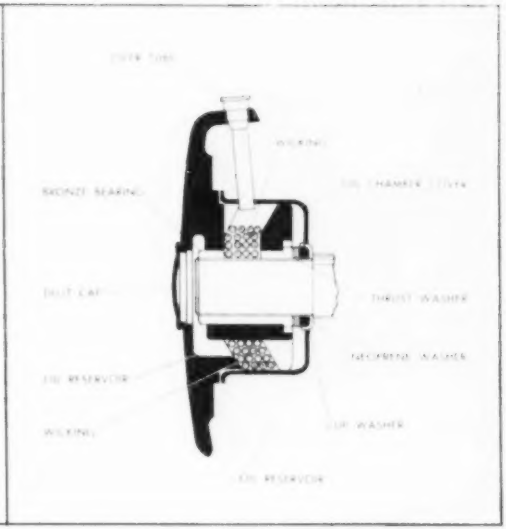
Sleeve-bearings should be designed so as to provide adequate circulation of the oil, which is usually a straight mineral, highly refined product, of viscosity or body suited to the operating conditions.

Normally oils ranging from 150 to 500 seconds Saybolt Universal at 100°F. will function effectually al-



Courtesy Leland Electric Co.

SLEEVE-TYPE BEARING WITH 100% WOOL WICK pressed in the cavity. Oil rises upward by capillary action to outlet at top, providing continuous circulation



Courtesy Brown-Bruckmeyer Co., Inc.

SLEEVE BEARING WITH RING WICKING has oiler tube above and reservoir below

though products of considerably lower viscosity may be used for some types of specialty motors. Stated in absolute units directly related to bearing design, these viscosities are in the range of 30 to 110 centipoises.

Oil groove location is watched very carefully by motor builders, as is also cutting away of the bearing metal. The theory, of course, is to direct the oil to the high pressure area, and promote the necessary pumping action when the rotor shaft is turning. The oil ring or chain, or the wick element delivers oil to the top of the shaft. This starts the circulation of a film through the bearing clearance, wedge action, plus pumping via the oil grooves completes the cycle.

Oil grooves cut in the low pressure surfaces of a bearing help to maintain a protective film at the high pressure area, provided the means of initial delivery of oil are adapted to the constructional and operating conditions and the grooves are connected or located with respect to each other and the point of maximum bearing pressure so that they provide for not only complete and ready distribution of lubricant throughout the bearing clearance space, but also a way for collection and subsequent flushing out of any abrasive foreign matter which might gain entry to impair lubrication.

How oil grooves function in service will be of interest. Normally, they provide an initial receptacle for receiving the oil as it passes into the bearing from the lubricator, thus serving as a means for distributing lubrication lengthwise along the bearing so that as the moving surface of the rotating or sliding element passes the grooves or chamfers, it will take up an adequate protective film of lubricant. In theory, this is thick film lubrication.

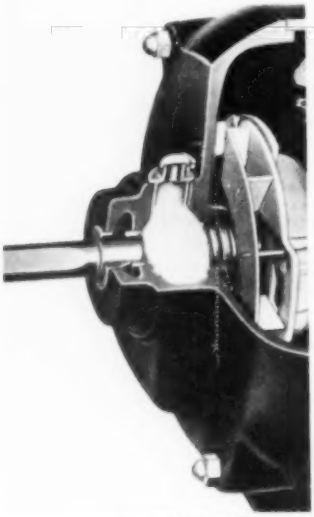
By suitably designing a system of grooving provision can be made for circulation of oil alternately from the center of the bearing to the outer ends and back again. How intricate such a layout would have to be would depend primarily upon the means of initial lubrication. Where sight feed or drip lubrication is involved, or in other words periodic lubrication with just about the right amount of oil to maintain an adequate lubricating film, grooving will play a more important part than where flood lubrication is employed. Well designed grooving also prevents excessive oil leakage at the ends of the bearings.

Grooving should be confined to those parts of the bearing which carry the least load. Oil must flow from a low pressure area to a zone of higher pressure. Should this latter be grooved to any extent there may be the possibility of oil being carried from the bearing, the lubricating film impaired, waste increased, and the development of abnormal wear. In a two-part motor bearing only the top bearing normally is grooved. No sleeve bearing should be cut away or have the continuity of its surface altered by grooves within fifteen degrees either way of the point of maximum pressure, otherwise uniformity in the oil film may be impaired. Furthermore, the lubricant should wherever possible be led into the bearing at the point where pressure is lowest so that the wedge action set up by chamfering will aid in film formation.

Meet the Author

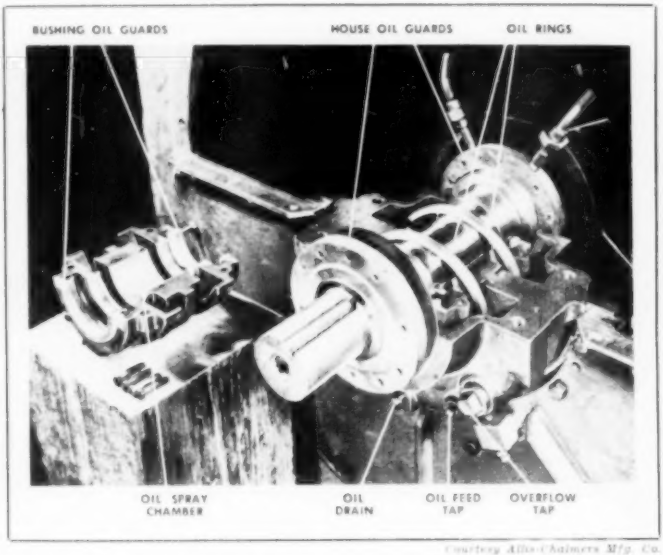
Allen F. Brewer, editor, of The Texas Co.'s magazine *Lubrication*, is attached to the technical and research division in the New York offices. He is a graduate of M.I.T. with a B.S. in mining engineering and metallurgy. In World War I he served as a Navy officer after attending the U.S.N.R. steam engineering school at Stevens Institute of Technology.

Mr. Brewer joined The Texas Co. in 1919. Until 1922 he was lubrication engineer at the Port Arthur, Texas, refinery, at which time he was transferred to the technical and research division.



Courtesy Century Electric Co.

SLEEVE BEARING WITH WOOL YARN assures clean oil flow

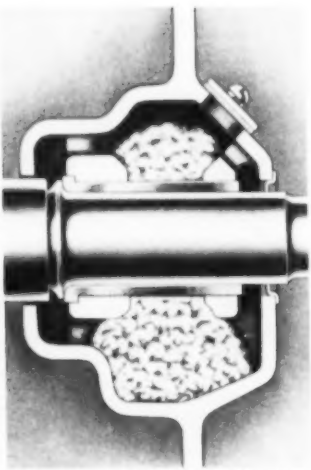


Courtesy Allis-Chalmers Mfg. Co.

CAPSULE TYPE SLEEVE BEARING with pressure equalizing vent pipes on the inner housing oil guard, useful at high speeds

The ring-oiled sleeve bearing utilizes its oil grooves and the passages at each end of the bearing to return the oil to the reservoir in the base; at the same time this return oil will flush out any nonlubricating material before windage can draw it through the bearing.

The limited quantity of oil in a sleeve-type motor bearing and the rapid rate of circulation requires careful consideration of both the quality and the probable operating viscosity. As this latter is influenced by temperature, the operating range should be ascertained and the viscosity of the lubricating oil decided upon accordingly. Not much cooling occurs other than by radiation of heat from the exterior of the bearing or its oil reservoir. Yet, even this comparatively small area normally keeps bearing temperatures well below the danger point, and usually comfortable to touch. The oil reservoir in the modern ring-oiled motor bearing also will be of adequate capacity to give the oil some time to rest and settle out any sediment or foreign matter that may have been picked up through windage or penetration. This occurs more rapidly with lighter oils.

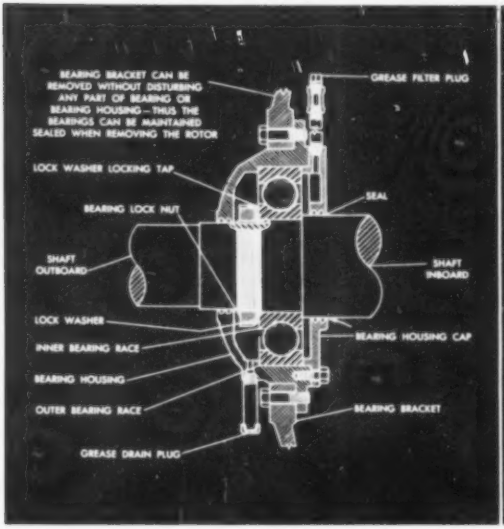


Courtesy Fairbanks-Morse & Co.

SLEEVE BEARING WITH OIL-SOAKED WOOL WASTE packing not in direct contact with shaft

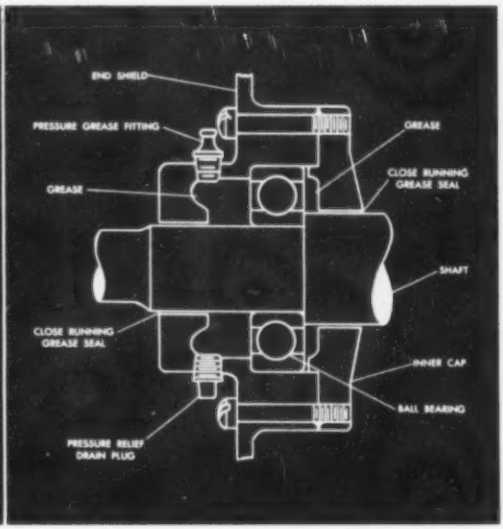
Courtesy Electric Machinery Mfg. Co.

PRESSURE LUBRICATION furnished by oil pump worm-geared to motor shaft. Oil rings provide lubrication during start-up or in case of pressure failure


BEARING BRACKET CAN BE REMOVED WITHOUT DISTURBING ANY PART OF BEARING OR BEARING HOUSING—THUS THE BEARINGS CAN BE MAINTAINED SEALED WHEN REMOVING THE ROTOR
GREASE FILTER PLUG
LOCK WASHER LOCKING TAP
BEARING LOCK NUT
SEAL
SHAFT OUTBOARD
SHAFT INBOARD
LOCK WASHER
INNER BEARING RACE
BEARING HOUSING CAP
BEARING HOUSING
OUTER BEARING RACE
BEARING BRACKET
GREASE DRAIN PLUG

Courtesy Electric Machinery Mfg. Co.

BALL BEARING TYPE motor bearing assembly uses grease as lubricant



Courtesy General Electric Co.

BALL BEARING TYPE FOR A COMPLETELY ENCLOSED motor uses outboard filler fitting

Settling and radiation becomes more effective when the level is not carried too high. This is why renewal of lubrication is important. Provided there is an oil filler and gauge installed (to control the oil level) it will be more cleanly and economical to add oil at this point while the motor is idle, to about one-eighth of an inch from the top, instead of filling through the inspection port at the top. The latter procedure often leads to waste through over-flow.

Too much oil can cause oil creepage into the motor. This may be accelerated by windage along with the development of oil spray where the oil level is carried too high, or if the oil overflow is not large enough. Oil which is carried to the top of a ring-oiled bearing must be taken care of and returned to the reservoir as rapidly as it is delivered by the ring. Otherwise, as stated, oil may accumulate in the upper part of the housing ultimately to be forced into the interior of the motor. This is detrimental to the coils, for oil-soaked insulation becomes a fire hazard and often requires a repair job.

To prevent this and also to protect the armature coils and pole windings, motor builders install oil baffles, throwers or labyrinth packing on the motor or inboard side of the bearing and oil filler plugs on the side of the bearing housing. Such devices in particular prevent direct circulation of air from the outside and through the bearings. In company with proper grooving of the bearing metal to permit ready distribution and return of the oil, they are regarded as adequate assurance that effective lubrication be maintained.

A sealed vapor and spray chamber at each end of the bearing also will function to detain oil vapor and spray which may be thrown off by the oil rings. Provision to return this oil to the reservoir in the base of the bearing is of particular advantage in maintaining economy and cleanliness.

Any lubricant present elsewhere than in the lubricating system may very easily develop a hazardous or sloppy condition which should be corrected as soon as possible. Attention to bearing design and adoption of sealing devices which will positively keep the lubricant where it belongs and prevent entry of foreign matter assures of dependable operation.

Ball and Roller Type Bearings

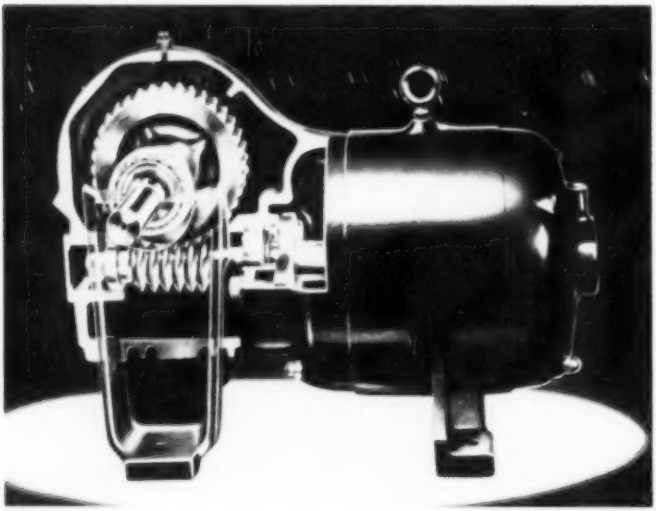
The use of ball bearings imposed on added responsibility upon the bearing manufacturers, as it required improvement of bearing seals, not only to extend the life of the quality lubricants which were necessary for lubrication, but also the prevention of entry of contaminating foreign matter. Effective sealing also reduces windage.

Low power consumption likewise became a factor in the development of bearings for the fractional horsepower motor, as this was proved to be a function of lubrication. Grease research was concentrated upon the study of ball and roller bearing greases of low torque characteristics, likewise maximum stability. Grease is often favored in that it is more easily retained by some bearings than oil.

The duty of the lubricant in a ball or roller bearing is extended beyond actual lubrication. The ability to prevent actual metallic friction must be supplemented by the protective ability, whereby the lubricating film is such that corrosion is prevented, even under a wide variation in atmospheric conditions. The oil industry provides for this by adding carefully selected anti-oxidants to greases for such service.

Actual contact between metallic bearing surfaces of the balls or rollers and their cages or retainers is the principal cause of wear due to development of metallic or solid friction. Rolling motion is essentially involved, meaning that in a properly designed bearing which has not been subjected to abnormal wear, the possibility of sliding contact will be relatively negligible. A lubricating film of suitable thickness and body to keep the metallic surfaces apart under the prevailing speed and pressure enables fluid friction to supplant solid friction. Grease functions like thick-film oil lubrication in this regard.

The sealed-type of prelubricated ball bearing is being widely used in motor service today where speed con-



Courtesy Master Electric Co

MULTIPLE BALL BEARINGS required on this speed changer

trol and low power consumption are of chief importance. This includes household equipment such as vacuum cleaners, also small high speed machine tools, some types of textile machinery and industrial type motors up to around 200 hp. The relation of the type of lubricant to speed is often overlooked. Where speed must be accurately controlled in precision equipment, low starting and running torques are most essential.

The service has an influence upon the type of seal used. The purpose of the seal is to prevent leakage of lubricant or entry of contaminating foreign matter. A variety of seals have been developed including felt and cork washers or gaskets, metallic slingers, dust collars, expanding leather devices, grease-filled grooves, or various combinations of these.

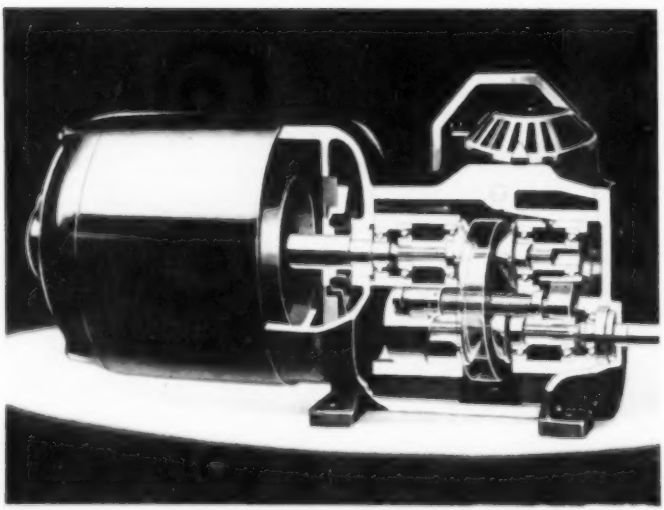
Ball or roller bearings in motor service, being lubricated most generally by grease and devoid of lubricant circulation beyond the bearing, must be serviced as units.

Grease for motor ball bearing lubrication should be as free from acid-forming tendencies as possible in order to insure adequate protection of the highly polished metallic surfaces. In effect, this involves manufacture of an essentially neutral product and, of course, the absence of fillers. The presence of any material that might give rise to oxidation and corrosive reaction, or to decomposition or settling is also objectionable. Such a grease should contain a highly refined oily constituent having high resistance to oxidation. This oil should be combined with carefully selected, high-grade soaps. Inhibitors usually are added to further improve the resistance to oxidation. Mechanically the grease should be easy to apply, have low starting and running torques, be adhesive (not throw off), withstand heat, be highly stable and resistant to leakage. When very high temperature service is involved up to around 350°F the grease should be specially prepared to function under heat conditions.

Normally a grease lubricated ball bearing should not be filled more than half full. This means the pressure guns should be carefully handled for at best the amount can only be estimated, unless the bearing is hand packed. Too much grease can cause over-heating and leakage past the seals.

The trend in motor design is more and more to build a unit which will be immune to external conditions. The modern explosion-proof motor is typical. Here, not only the bearings but also the windings are insured against entry of any type of foreign matter. Any leakage of lubricant in such a unit would obviously be to the detriment of not only the bearings but also the adjacent motor parts. In this development high temperatures also had to be considered, especially for motors designed for steel mill, stoker, and economizer service, and textile finishing. The effect of high temperature on certain sealing materials involves deterioration. The effect of high temperature on lubrication is to reduce the viscosity or consistency of any lubricant. The extent to which this will occur depends, of course, upon the original body of the product. Unless the latter is of the nature of a steam cylinder oil and possessed of adequate viscosity, at steel mill temperatures considerable leakage may result from certain types of bearings. For this reason, steam cylinder stocks are used in certain grades of high temperature ball and roller bearing greases. A lubricant of this nature, along with a suitable bearing seal, will keep down leakage to a marked degree even under very high temperatures.

Vertical motor installations have called for considerable study of sealing devices. The ball bearing has proved to be particularly adaptable



Courtesy Master Electric Co.

ROLLER AND BALL BEARINGS in a right angle gearhead motor

to such motors, due to its dependability under high speeds and intensive thrust loads. When such motors are designed for oil lubrication, cups are connected through ducts to the bearings housings. The oil level in the system should be kept well up to assure of thorough lubrication.

A bearing seal must not only seal, but also it must show practically no wear in service, otherwise, the purpose may be more or less defeated. Washer type seals may consequently be unsatisfactory, although the rate of wear will depend upon the quality of the material. Adjusting springs can be used in connection with washer or leather cup seals in order to keep the material in close contact with the shaft or journal surface. This will compensate for wear and enable the bearing to retain its lubricant more dependably.

Grease groove seals are used to prevent leakage of lighter lubricants. they are also relatively simple and inexpensive to design. They must be periodically examined, however, in case the sealing grease requires renewal. Otherwise possible glazing of the surface of this latter where it comes in contact with the rotating shaft might result in sufficient clearance to allow leakage of the bearing lubricant.

Very heavy bodied greases of high melting point are adaptable to service as grease seals, provided they show no tendency to separate oil from soap, and contain no material which might be abrasive to the shaft surface. Grease grooves can also be used together with felt washers in certain types of service, although this may require extension of the length of the bearing housing.

Relation of Lubrication to Insulation In any piece of electric power generating or transmission machinery, the insulation must be in good condition if the machine is to operate properly. Lubrication, especially over-lubrication, can affect motor life because it can cause oil-soaked insulation. Oil travel along the shaft from an over lubricated bearing also may carry dirt or dust accumulations to the windings. All this can result in higher operating temperatures. Too much heat and the softening solvent effect causes oil soaked windings to deteriorate rapidly.

This is fully realized by motor builders and operators in industries where high running temperatures and dirt must be considered. They counteract the effect by using double shielded or sealed bearings, following a regular and carefully controlled relubrication procedure, and enclosing motor drives in pressurized rooms when practicable.

Cleaning and Flushing Procedure

Cleaning and flushing is an important procedure in motor bearing maintenance. The frequency of such a procedure will be governed by the type of bearing and the conditions to which it is exposed. Ring or chain oilers on sleeve-type bearings automatically flush themselves to settle any foreign matter in the reservoir below the bearing. Wick oilers or other methods of periodic lubrication are not so effective; here, if foreign matter can get in, it stays there until the bearing assembly is flushed and cleaned. The same holds true for the grease-lubricated ball or roller bearing.

It is especially important to keep abrasive contaminants out of ball or roller bearing greases as churning of abrasive foreign matter with the grease, between moving parts, which are precision-built to clearances of only a few ten-thousanths of an inch, will cause serious damage to the bearing elements. For this reason, specialty greases for ball and roller bearings are prepared from carefully selected and filtered ingredients, and even later filtered by some ball bearing manufacturers, if they are to be used in pre-lubricated, sealed-type precision bearings. In service, the seal should be so effective as to keep such lubricants in this high state of purity.

To set any hard and fast rule, even with the best of seals, is unwise, however, due to the wide variety of service to which motors must be subjected, particularly in industrial or power plants. The extent to which dust, dirt, metallic chips or scale may be present in the air or be drawn into any bearing will, of course, be an influencing factor.

Oil-lubricated bearings can be drained if an outlet is located in the base or lower part which can be tightly plugged in service; this will prevent leakage during operation. Sometimes this can be elaborated upon by an arrangement of nipples and pipe fittings terminating in a sight gage glass. This facilitates not only cleaning, but also observation of the oil level in the bearing. Oil lubricated sleeve-type bearings should be gaged regularly for oil level in reservoirs, and only enough oil should be added to bring the level to the proper height.

Sleeve-type motor bearings will often require more frequent cleaning than ball or roller bearings, as their housings cannot always be so tightly built. With the former, cleaning may be necessary or advisable at periods ranging from every two weeks to every several months according to the extent of dust or dirt in the surroundings; whereas a properly housed ball or roller bearing may function much longer under the same conditions. On the other hand, such bearings are more delicate from the viewpoint of constriction, and therefore, the lubricant should not be allowed to become so contaminated as to cause abrasion, rough running and noise.

Wherever grease lubricated ball or roller bearings are involved and drainage cannot be readily carried out due perhaps to the body or consistency of the lubricant, the grease should be wiped out thoroughly at the period of cleaning. It is also practicable to flush some types of ball and roller bearings with hot oil. Such bearings can be all the more completely cleared of used grease if the drain plug is removed when new grease is applied, as it is when flushing.

Ring-oiling systems possess natural advantages in that the flood of oil which is constantly passing through the bearings tends to wash out any grit, dirt, dust or metallic particles that may have gained entry. As a result, wear is reduced to a minimum, just as long as the oil in the system does not become so highly contaminated as to be unable to precipitate such foreign matter during its period of so-called rest. The washing action in a flood lubricated bearing naturally causes gradual accumulation of foreign matter, therefore, the condition of the oil should be carefully watched, and the system drained when any excess of dirt becomes apparent.

A flushing oil wash (using an automotive type of crankcase flushing oil heated to around 140 F.) will normally take up and remove such material.

A number of factors can affect electric motor operation. They include overloading, extremes of temperature, vibration, dust and dirt, and lubrication. Often, the most aggravating is lubrication because is seems so simple. Only two bearings are involved. Offhand, they seem to be well housed, so a shot of grease from a pressure gun or some oil (if the bearing is built for oil) is all that seems necessary now and then.

"Now and then" is what causes so many motor bearing troubles. Furthermore, so often, it's not the lubricant but the way it is applied. Too little can lead to bearing wear through starved lubrication. Too much can cause seal failure or oily windings. A regular schedule for relubrication (after studying the operating conditions along with the bearing design), and a regular schedule for cleaning can go a long way in promoting motor life in line with manufacturers standards.

NOTE: This article, made available to the readers of PETROLEUM PROCESSING, by The Texas Co., appeared originally in its magazine Lubrication, Jan. 1950 under the title Electric Motor Lubrication.

OFFICERS AND DIRECTORS chosen at the recent annual meeting of the Western Petroleum Refiners Assn. include:

Front Row (L to R): Max Fisher, Aurora (new); Reid Brazell, Leonard; H. T. Ashton, Socony-Vacuum; W. J. Cartlidge, Deep Rock; J. C. Day (executive secretary); Ray Tollett, Cosden (president); Fayette Dow (general counsel); R. W. McDowell, Mid-Continent; J. W. Warner, Tide Water; Everett Wells, Ashland (new).

Back Row (L to R): F. H. Dunn Wilcox; R. G. Bandy, Midland Co-operative; Oscar Cordell, Barreo; Rex Blazer, Allied; John S. Wertz, Vickers; F. W. McCurry, Derby (new); Brown Meece, Sinclair; Lee Haugen, Cities Service; A. M. Hughes, Phillips; J. P. Langfitt, Pure; J. W. Vaden, Skelly (vice-pres.); L. D. Mann, Cities Service Refining.

Not Shown: T. A. Helling, Elreco; R. R. Irwin, Socony-Vacuum; H. J. Kennedy, Continental (vice-pres.); R. E. Luton, Ohio Oil; F. L. Martin, Sunray (vice-pres.); T. M. Martin, Lion; M. H. Robineau, Frontier; R. V. Rodman, Anderson-Prichard (vice-pres.); C. M. Boggs, Kanotex; L. B. Simmons, Onyx; G. C. Woodruff, Globe (new); Bruce K. Brown, Pan-Am Southern (new).

Refiners Look at 'Problem Children'

Heavy fuel oil and gasoline quality get spotlight at Western Petroleum Refiners Assn. meeting

By D. P. THORNTON, Jr.
Southwestern Editor

THE two "problem children" of the refining branch of the oil industry — heavy fuel oil and gasoline quality — came in for prominent consideration during technical ses sions of the Western Petroleum Refiners Assn. at San Antonio March 31-April 2.

Heavy fuel oil production against a steadily declining market for the material has for some time been a severe headache to refiners, the principal causes for the pile-up of stocks being Dieselization of railroads and increased year-around availability of natural gas in the North and East.

Converting residual fuels into coke has several attractions for the refiner with too much No. 6. He can shut down the coker when the heavy fuel oil call is strong and vice-versa. If coke piles up, some nearby vacant land is adequate storage.

On the debit side, cokers cost money and the gasoline produced is low in octane and often high in sulfur. It is possible there still might be surplus gasoline on occasion, but this usually is less a problem than excessive heavy fuel stocks.

Trends in motor fuel volatility and its effect on utilization in the engine, as well as means for upgrading naphthas and natural gasolines as blending agents, featured the discussions on gasoline. The advan'ages of catalytic reforming in this respect, while also reducing the volume of off-gas, and in the production of materials separately valuable as chemical raw materials or petrochemical intermediates were brought out.

Coker Economics

The pay-out prospects for delayed coking as applied to one specific refinery, and probably to many more with appropriate minor adjus'ments, was presented as "Economics of Coking Residual Petroleum Products" by R. T. Colquette and Carl W. Peters, Pan-Am Southern Corp. They pointed out that in the usual evaluation no economic advantage in coke production develops in areas having a high fuel oil demand, whereas the increased value of products from coking, as compared to fuel oil production, usually is not large enough to justify the capital expenditure involved.

These authorities consider coking primarily from the standpoint of providing additional light ends from a limited supply of crude, rather than a method of reducing residual fuel production. Three cases are compared in Table 1: The base case of a 30,000 b/d refinery producing 25% on crude as No. 6 oil, increasing gasoline production through coking and thermal or catalytic cracking facilities, and increasing gasoline production through an increase in volume of crude handled.

In these examples gasoline production increased 4,650 b/d over the base case by the installation of coking and

cracking units. To achieve this increased gasoline production by increasing crude throughput required an additional 7,150 b/d of crude oil. By coking, fuel oil is reduced 6,700 b/d, increased 2,150 b/d when charging more crude.

Based upon the estimated yields for coker operation vs. those for increased fuel oil production, and considering that increased catalytic cracking capacity will be provided for conversion of coker gas oil to gasoline, a payout of three years is indicated under current price structures (Group 3) and federal taxation, as indicated in Table 3. It is shown that the net annual profit from coking is substantially equal to the difference between the fuel oil price and that realized from coker production; hence the payout is highly susceptible to the effects of fuel oil price fluctuations.

Coking as an alternative to increasing crude processing capacity, as shown in Table 2, assumes first that the quality of the two gasolines are substantially equal and that cracking requirements are essentially identical. The major difference in investment then becomes the $1.1 million greater estimated cost of a coker over a topping unit. In this case, the payout time is predominantly affected by the price differential between fuel oil and crude. With current prices the payout is 0.9 year. From a survey of prices, tax laws and investment required over the past seven years, it is shown that when the fuel oil-crude price differential is less than 60¢ per bbl., payout tends toward marginal, and becomes particularly attractive when differentials are higher.

This study is limited to gasoline production, whereas with low sulfur crude approximately half the coker gas oil could be diverted after mild treating to Diesel oil, or as No. 2 fuel. Also, if high sulfur crude is used, coker gasoline will be very sour and require desulfurization. This problem has been encountered by Pan-Am and reported neither insurmountable nor of such cost as to materially affect coking economics.

Motor Fuel Volatility

An extensive review of motor fuel volatility trends and the effect of various refinery processes on components used in blends was made by Phillips Petroleum Co. research personnel, based on U. S. Bureau of Mines motor gasoline surveys during the period 1937-1951. As a measure of volatility R. C. Alden, H. J. Elder and Elizabeth Aldrich have used the sums of the 10% plus 30% and 70% plus 90%, rather than the 50% evaporated temperature, in their report, "Some Aspects of Motor Fuel Volatility."

Table 1—Basis for Evaluating Coking

Material Balance	Base, b/d	Additional Capacity, b/d Delayed Coking	Added Crude
Crude	20,000	20,000	27,150
Gasoline:			
Virgin	7,500	7,500	6,500
Cracked (Incl. Alk. Polymer)	7,600	8,900	8,250
Coker		1,700	
Total	15,100	18,100	24,100
Distillates	6,000	6,000	6,000
Fuel Oil:			
Reduced Crude	7,500		9,500
Cracked	1,400	1,900	1,250
Total	8,900	1,900	10,650
Coke (Tube)		(250)	
Fuel Gas (FOE)	1,200	2,300	1,650
Charge to Processing Units:			
Topping	20,000	20,000	27,150
Catalytic Cracking	9,000	12,250	32,600
Thermal Cracking	4,000	3,950	3,500
Delayed Coking		7,200	

Table 2—Appraisal of Coking vs. Crude Processing

	Increase over Base Case, $ at Coking	Crude Processing	Coking over Crude
Realization:*			
Gasoline	7,140,000	7,140,000	0
Fuel Oil	140,000	140,000	280,000
Fuel Gas	410,000	1,180,000	740,000
Coke	500,000		500,000
	8,440,000	8,460,000	— 10,000
Costs:			
Crude (b)	0	6,000,000	—6,000,000
Taxed Crude	1,110,000	0	1,110,000
Coking	500,000	0	500,000
Topping	0	150,000	—150,000
Cracking	485,000	485,000	0
	1,985,000	7,515,000	2,620,000
Gross Savings	3,565,000	945,000	2,610,000
Net Savings			
(52% Taxes)	1,850,000	630,000	1,200,000
Investment	$5,600,000	$4,500,000	1,100,000
Payout, years	3.0	7.2	0.9

* Gasoline 10¢/gal.; Fuel Oil $1.50/bbl.; Crude (b) $2.65/bbl.; Coke $5.50/t.

Over the 11-year period they found in general a substantial increase in average volatility of regular and a lesser increase in premium grades except for the West Coast, both in summer and winter gasolines. However, volatility changes have been literally "all over the map." Perhaps equally important, though perhaps not emphasized, have been the changes indicated by these trends in the fuel which the average car has had to accept during its useful life.

Front-end volatility still is increasing, and at the same time end point temperatures have been reduced. This latter trend is particularly evident in premium fuels except for the West Coast. Postwar changes (1947-51) have in general been less than was evident in the prewar (1937-41) and transitional (1941-47) periods. The pronounced reversal in volatility trends for the West Coast are believed to reflect increasing shortages of light ends and rapid application of catalytic cracking.

In studying the effect of blend components upon the volatility of a gasoline it was brought out that, for a base motor fuel of 8.3 Reid vapor pressure, adding butanized heavy catalytic cracked gasoline decreases volatility by increasing both the 10+30% and 70+90% evaporated temperatures; the greatest effect is on the latter.

Adding butane has the most pronounced effect upon front-end volatility, and debutanized natural gasoline (or vapor recovery gasoline) has almost the same effect on both ends of the fuel. Naturally, the base stock to which the ingredients are added is of great importance and the authors generalize that butane is the principal determinant of volatility differences between summer and winter fuel grades.

Refinery procedures decreasing average volatility are catalytic polymerization and fuel undercutting. Catalytic cracking has a comparatively small volatility increasing effect; alkylate in general has little effect. All other processes in general result in rapidly increasing average volatility.

It is shown in conclusion that the volatility increase in the 14-year period has resulted in generally more improvement in performance than in introducing vapor-lock and carburetor icing. Unfortunately, these difficulties unavoidably accompany improvement in easy starts and warm-up performance.

Various discussors to the paper agreed that the icing problem seems more serious than vapor locking, due to the fact that motorists driving automatic transmission cars are more conscious of the stalls it produces. They brought out that several additives, among them isopropyl alcohol in concentrations up to 2%, can be used to minimize icing; carburetors can be water jacketed to warm them in winter and cool them in summer. In the Southwest, where there is an abundance of natural gas reserves, it appears likely that a pronounced use of light ends is to be expected.

Discussors pointed out also that many state gasoline specifications are limiting as to vapor pressure and, particularly with winter grades, prevent motorists from receiving the full benefits available with vapor pressure up to 15 psi. Reid. Both specifications and test methods in some instances are outmoded and efforts should be continued to open the question of removing unduly restrictive specifications and test procedures.

Reforming Economics

An economic study of the value of catalytic reforming was given by T. A. Burtis and H. D. Noll, Houdry Process Corp., comparing various processing methods in a hypothetical 10,000 b/d refinery processing East

Texas crude. Their paper, "Houdriforming—Its Place in the Refinery," first pointed out that catalytic reforming is not only a valuable method of improving octane rating of naphthas while maximizing saleable liquid products, but also upgrades natural gasolines, effectively removes sulfur and permits very considerable aromatics production.

Two refineries with catalytic polymerization are considered: one with thermal cracking, the other with Houdriflow recycle catalytic cracking. To each is added reforming, either thermal or catalytic, and for catalytic operation, two reforming severity levels to produce seven examples for discussion. Of the total gasoline, 75% is motor grade, 86 Research and 25% premium, 92% Research. "outside" butane is to be purchased when needed for vapor pressure requirements.

The case of thermal cracking and reforming with cat. poly produces only 15.6 vol.-% premium gasoline even with deep reforming and TEL requirement of 3 cc./gal. Case 2, Houdriforming substituted for thermal reforming, gives desired gasoline quality with 3 cc. TEL in the premium and 2.3 cc. in the motor blend. Case 3, more severe reforming than in Case 2, reduces lead requirements to 1.85 cc./gal. for premium and 1.75 cc. for motor.

Case 4, involving substitution of catalytic for thermal cracking and no reforming, permits only 10 vol.-% premium gasoline with 3 cc. TEL because the balance of catalytic gasoline plus 3 cc. TEL must be used in the motor blend to compensate for low octane S.R. naphtha. Case 5, adding mild thermal reforming, yields both premium and motor grade gasolines in desired degree with 1.8 cc. TEL/gal. Case 6, moderate Houdriforming substituted for thermal reforming, yields a premium using 0.6 cc. TEL/gal. and motor requiring 0.7 cc. TEL. With still milder Houdriforming, Case 7, TEL requirement is advantageously increased to 1.05 cc. for each grade since the requirement of Case 6 was so low.

In economic summaries of yield and payout, federal taxes were excluded. Comparing thermal cracking refineries of Cases 1, 2 and 3, if a new Houdriformer is installed instead of a new thermal reformer, the respective differential profits of Cases 2 and 3 over Case 1 are $1291 and $1308 per calendar day, retiring the higher incremental investment of $475,000 in a year. If an existing thermal reformer is replaced with Houdriforming and no credit allowed for re-use of parts, the $1291 daily return will retire the $1,050,000 investment in 2.22 years.

Comparing catalytic refineries of Cases 4 through 7, differential earnings of Cases 5, 6 and 7 over Case 4 show, respectively, a decrease of $113 per calendar day and increases of $527 and $567. Comparing earnings of the thermal reforming plant (Case 5) with Houdriforming processes, Case 6 is $640 higher and Case 7 $680 higher per calendar day. Payouts on investment for the four cases, respectively, are 1.40, 1.68, 1.72 and 1.71 years.

Similar data for a mixed base stock, naphtha from Scurry crude, a sour West Texas naphtha, California naphtha and the East Texas naphtha used for the economic study are given. The desulfurizing studies at several operating severities indicate at most that 3.8% of sulfur in the feed appears in the product. The adaptability of Houdriforming to aromatics production also is illustrated and, though generally a function of the naphthene and aromatics content of the charge, aromatization of some paraffins is shown. Loss of yields other than shrinkage is low.

Reforming Catalyst

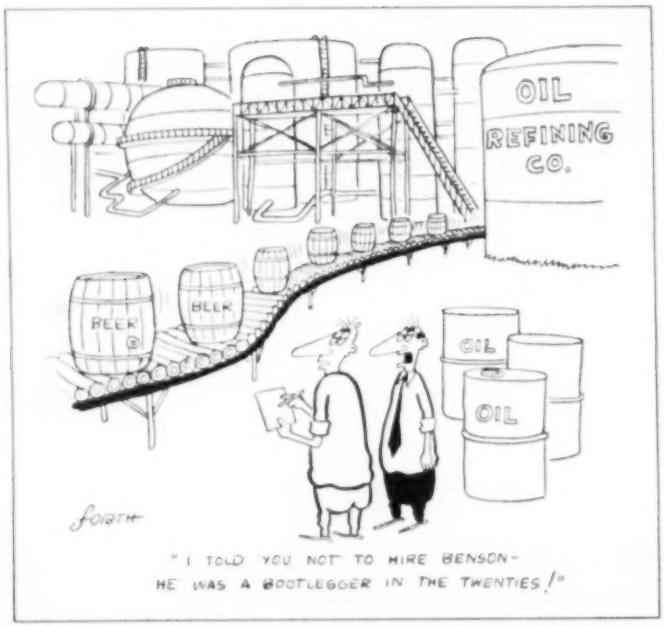
M. J. Fowle, R. D. Bent, B. E. Milner and G. P. Masologites of Atlantic Refining Co. in their paper, "In Reforming—it's the Catalyst that Counts," hold that the catalyst greatly influences daily operating economics in reforming and the complexity of the required processing equipment.

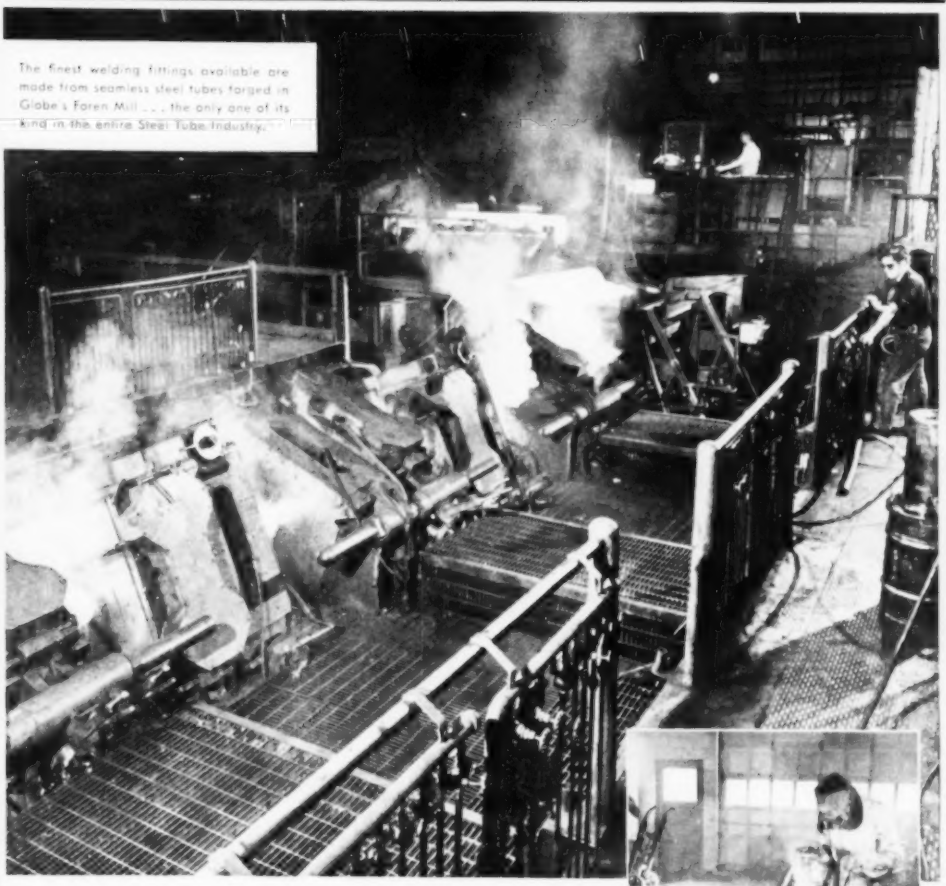
Catalyst requirements are selectivity (controlling racking while promoting dehydrogenation and isomerization), stability (maintaining desired yield-octane relationships over an extended life) and stamina (performing satisfactorily under many varied refinery operating conditions).

Utilizing pilot plant data from a variety of feed stocks, yields with Atlantic's reforming catalyst of debutanized products ranged from a low of 84.4 to a high of 93.1 vol.-% of feed. Propane and heavier ranged from 96.2 to 101.7. Yields of methane-plus-ethane were consistently below 1 wt.-% of feed, while purity of the recycle hydrogen stream was about 95 mol-%, suggesting its use for purposes other than as a fuel.

The catalyst also is demonstrated by the data presented as changing little after contacting with feed for a total of 30 bbls. per pound of catalyst. It may be regenerated in place when used under severe reforming conditions or following a major unit upset. Water injection studies indicate no deactivation or change in product distribution. The catalyst is an excellent desulfurization medium and, although temporarily poisoned, returns to original activity when the sulfur level in the charge is reduced or the recycle hydrogen stream is desulfurized.

The authors also investigated abnormally high concentrations—up to 10,000 parts per billion—of volatile arsenic compounds which might conceivably be present in some naphtha feeds; there were neither permanent nor temporary harmful effects to the catalyst.





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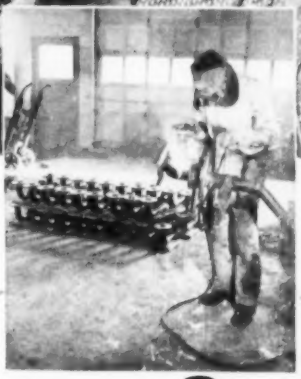

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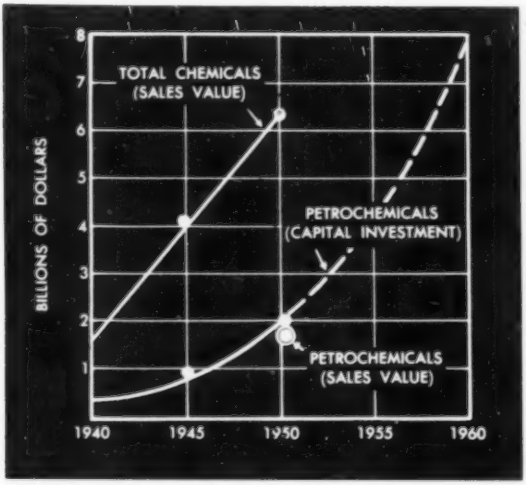


$8 BILLION INVESTMENT BY 1960 is estimated for the petrochemical industry, based on present rate of expansion

Sales values, total chemicals, from Chemical Economics Handbook, Stanford Research Institute

Progress in Petrochemicals

By MAX NEUHAUS and NOLAN B. SOMMER
Jefferson Chemical Co., Inc.

THROUGH general usage the term "petrochemicals" has come to refer to that large group of chemicals now derived from petroleum sources. These sources include natural gas and the entire range of materials present in crude petroleum as it is taken from the well, in addition to those derived from the crude in the refining process.

Petrochemicals had their true commercial inception during the 1920's, although Standard Oil Company (N. J.) began making alcohols from petroleum raw materials as far back as 1919. Carbide and Carbon pioneered in research on chemical synthesis from hydrocarbon gases, and as a result, developed an impressive array of aliphatic products, most of which have since found widespread commercial use.

From this beginning, the petrochemical industry has grown rapidly into a gigantic business participated in by over sixty companies which operate more than one hundred plants in the United States alone. This relatively young industry has almost doubled in size in each of the last three five-year periods, and the available raw materials should allow this rapid rate of growth to continue for a long time to come. The industry has already reached the stage where its products penetrate every aspect of our daily life — the food we eat, the clothes we wear, the construction of our homes, and the facilities by which we travel.

Let us take a closer look at this giant—petrochemicals. Let us attempt to get a clear picture of its size, both volumewise and dollarwise; its participants, their locations and their scopes of operation; and its products, their origin and their place in our economy. May we emphasize briefly too the almost unbelievable expansion occurring in this phase of the chemical industry at the present time. Will this rapid growth continue? Will petroleum as a source of chemicals continue to encroach upon what were once private domains of coal and agriculture? And how long will our estimated reserves of crude oil and natural gas continue to support such expansion?

Size of the Industry

In 1940 there was a capital investment of $350,000,000 in the petrochemical industry, and output was estimated to be about four billion lbs. yr. By 1945 these figures had grown to about $1 billion and 10 billion, respectively. In 1950 the industry is estimated to have produced about 17 billion lbs. of chemicals with a sales value of $1.6 billion. The total investment is now said to be approaching $2 billion. It has been estimated that continued expansion will in ten years bring total investment to $8 billion and total productive capacity to 64 billion lbs. The graph above illustrates this growth and projected growth.

The growth of petroleum as a major chemical raw material has brought about a profound change in the character of the chemical industry. While in 1925 aliphatic chemicals comprised less than one-third of the total organic chemical production, this had changed significantly by 1945 when about two-thirds of the total was accounted for by the aliphatics. At the present time this trend seems to be continuing, although it should be pointed out that huge volumes of various aromatics are now beginning to make their appearance from petroleum.

Although the petrochemical industry was born in the East and Midwest, the Southwest—in par-

* This article, by Messrs. Neuhaus and Sommer, was presented originally as a paper before the 119th meeting, American Assn. for the Advancement of Science, Philadelphia, Dec. 30, 1951. It has just been released for publication in PETROLEUM PROCESSING by Jefferson Chemical Co., Inc.

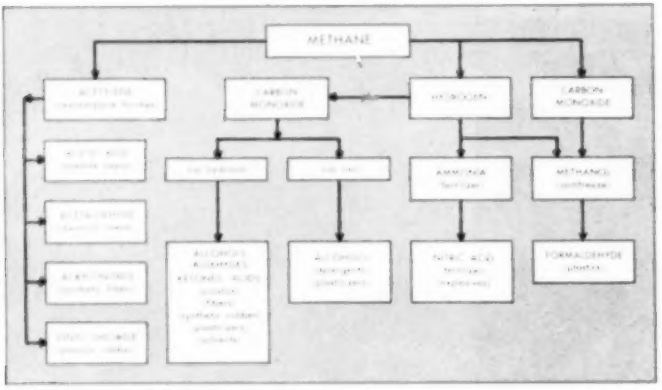


FIG. 1 Methane-derived products

ticular Texas and Louisiana—with its huge concentration of petrochemical plants can now almost claim this vital industry as its own. More than fifty such plants are located along the Gulf Coast alone, and over 85% of the total industry is concentrated within a radius of 200 miles of Houston. With over 70% of our total oil production originating in Texas and Louisiana, and with comparatively favorable labor conditions, taxes, utility supply, and political and popular support continuing to exist there, it is reasonable to expect that this area will continue to grow. Considerable expansion is now taking place toward the Northeast, especially in Kentucky and Tennessee.

The advantages which exist in the Southwest generally outweigh the primary objection to location in that area that is, distance from points of use. Of course, as more and more plants concentrate there and as they must consume chemicals as well as produce them, this objection will gradually assume less and less importance. Paralleling this trend, however, is the trend toward higher raw material costs (due primarily to increased costs of locating new petroleum sources), higher taxes, higher labor costs, and a depleting water supply. Everything considered, however, it is felt that all these factors will operate in future years in such a way that this area will continue to be a choice location for petrochemicals.

Companies

As mentioned previously, Carbide and Carbon was the pioneer in the petrochemical industry. Moving south about 1941, it was followed by du Pont, Dow, Monsanto, Cyanamid, Celanese and other major chemical companies. More recently, growth has taken place also through joint efforts of chemical companies and petroleum companies, chemical companies and natural gas companies, and chemical companies and rubber companies, all resulting in new concerns dedicated to the production and sale of chemicals from petroleum.

As far as recent expansions and those expected in the near future are concerned, most indications are that the bulk of expansion in the field will be made by the chemical firms—not the oil industry. However, the latter will continue to be exceedingly important factors in the business and their participation will continue to increase. Conditions peculiar to the chemical industry—large investments, huge research and development programs, short-lived markets and intricate chemical process know-how, all continue to be strangers to many oil companies. Over-all preoccupation of the petroleum people with satisfying the stable and growing market for petroleum products is, however, probably the most important factor in this situation.

A complete listing of the companies engaged in the production and sale of petrochemicals is indeed an impressive one. Such listings may be found in several places in the literature.[2, 4, 18, 19] However, in view of the remarkable expansion taking place *currently* in this industry, it is interesting and significant to note the new companies in the field and the tremendous sums being expended for this purpose.

Products

The chemicals now derived from petroleum sources are many. Some major products, with production figures, original sources and per cent now derived from petroleum, are shown in Table 1.

For discussing these and other petrochemicals, consideration by each specific hydrocarbon raw material source would seem to be preferable, starting with methane and proceeding up the series. These hydrocarbons are produced from refining operations and by subsequent processing, as well as being in some cases directly obtainable from natural gas.

Before launching into discussion by hydrocarbon raw material, it would seem appropriate to mention the direct oxidation of natural gas as carried out currently by Celanese, Tennessee Eastman, and others, to produce the primary oxidation products, methanol, ethanol and propanol, as well as the corresponding aldehydes and acids and acetone. This process involves an extremely difficult separation problem. However, it is said to be preferred economically over other processes for the production of certain materials. Formaldehyde is one of these.

Methane

Methane-derived chemicals are outlined briefly in Fig. 1. Methane is a major component of both natural and cracked gases. It makes up, on the average, about 85% of natural gas, 33% of the gas from thermal cracking and 18% of the gas from catalytic cracking.

Ammonia is outstanding among the heavy tonnage basic chemicals which come from methane by various processes. The amount of ammonia made by utilizing hydrogen produced from natural gas is increasing at a rapid rate more rapid, in fact, than the over-all ammonia production trend.

Table 1—Petroleum as a Source of Major Chemicals

Product*	Est. Annual Prod. U. S. 1950	Original Source	% Now derived from Petroleum
Ammonia[3]	1,800,000 tons	Coal	45% of H_2
Methanol[3]	150,000,000 gal	Wood, Coal	1949 nearly 80% from natural gas
Ethanol[3,4]	225,000,000 gal	Molasses, sulfite liquor, grain, etc.	57%
Isopropyl alcohol[3,4]	300,000,000 lbs		All
n-Butyl alcohol[3,4]	147,000,000 lbs	Molasses, Fermentation of carbohydrate	at least 25%
Octyl alcohols[3,4]	17,000,000 lbs	Fusel oil	50%
Glycerine[3,20]	220,000,000 lbs	Fats & Oils	16%
Benzene[20]	180,000,000 gal	Coal	7%
Acetone[20]	100,000,000 lbs	Molasses	50%
Acetylene[20]	414,000,000 lbs	Carbide	small but will grow significantly
Toluene[20]	20,000,000 gal	Coal	60%
Xylenes[20]	10,000,000 gal	Coal	86%

* References shown with each product are listed in the bibliography accompanying this article.

The current conversion of the Government's great Morgan'own, West Virginia, plant from coke to natural gas will certainly accelerate this increase. Ammonia's primary use in peacetime is for fertilizer, either as a directly injected gas, a water solution, or in the form of its various salts. Its oxidation to form nitric acid, and thus to provide nitrates which are also of major importance as explosives and as fertilizer, is a vital part of this whole picture.

The second most important methane-derived chemical from the standpoint of quantity is methanol. The manufacture of methanol may be carried out in equipment similar to that used for ammonia. Here carbon monoxide and hydrogen are the raw materials. While 71% of the methanol production was based on coal in 1946, 77% came from natural gas in 1948, and this figure is probably even higher now. Formaldehyde, and antifreeze currently consume an estimated 80% of methanol production.

Formaldehyde is a major raw material for the manufacture of phenolic resins. These resins are used almost entirely for industrial applications. They find everyday use in radio and television cabinets, telephone casings, electrical and cooking appliance handles and knobs, and bottle closures. These phenolics, as well as varnishes derived from them, are also widely used in the automotive industry, in foundry cores and molds, etc. They find widespread use because of their high strength.

Recently the Hydrocol process, the American version of the German Fischer-Tropsch process, has formed the basis for the operation of one huge plant currently getting on stream at Brownsville, Texas. This process involves the oxidation primarily of methane at temperatures as high as 1700° C. and pressures of 300 psig, to produce carbon monoxide and hydrogen. These materials are then caused to react over an iron catalyst to produce synthetic gasoline and diesel oil, but with the concomitant production of considerable quantities of organic chemicals. These chemicals include alcohols, aldehydes, ketones and acids in the range up to five carbon atoms, with ethyl alcohol and acetic acid estimated to be the two largest volume items. The annual production capacity of the Brownsville plant for these materials is estimated to be as follows:

Chemical	Quantity, lbs. yr
Acetaldehyde	9,100,000
Propionaldehyde	1,820,000
n-Butyraldehyde	3,750,000
Acetone	11,200,000
Methyl alcohol	750,000
Methylethyl ketone	4,750,000
n-Butyl alcohol	4,370,000
Ethyl alcohol	63,680,000
n-Propyl alcohol	14,400,000
n-Amyl alcohol	1,900,000
Acetic acid	24,700,000
Propionic acid	8,200,000
n-Butyric acid	8,200,000
n-Butyl ketone	370,000
Ethylpropyl ketone	600,000

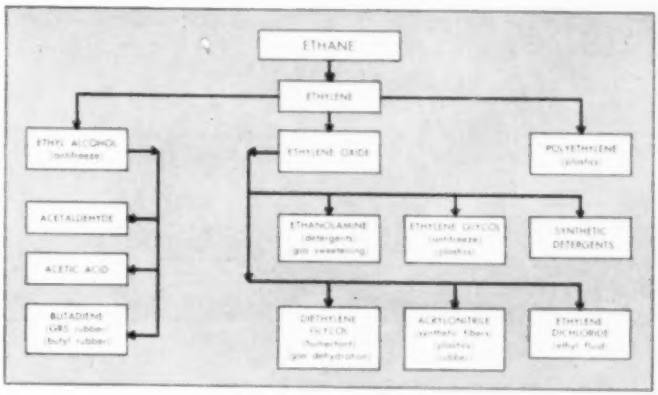


FIG. 2. Ethane-derived products.

The separation and isolation of these chemicals will be a huge and difficult task. If the Hydrocol process proves itself commercially it will, of course, have a profound influence on the petrochemical industry.

Carbon monoxide and hydrogen from methane may also be reacted with various olefins in the Oxo process to produce valuable products. Three companies are presently producing or are about to produce isooctyl alcohol, presumably based on propylene-butylene codimer, by this process. This alcohol is utilized primarily as a plasticizer intermediate. Various other concerns are considering Oxo alcohol production, and it may well be that longer chain materials from such production will find large-scale application in synthetic detergents and in other uses. Aldehydes are obtained in the first stage of the Oxo process, so marketing of the aldehydes as such, as well as the acids which can be derived from them, appears also to offer possibilities for the future.

The controlled oxidation of methane is also assuming great importance for the production of acetylene, which holds promise of rivaling ethylene for the future as the leading building block of petrochemicals. This process (Sachsse) was developed in Germany and now leads its competitors, the Wulff process and the Schoch process, as the preferred method of obtaining acetylene from natural gas. Few organic chemicals can compete with acetylene in versatility as a chemical intermediate. While the commercialization of many of its chemical reactions is only just beginning in this country, the future will certainly see many tank car chemicals based on acetylene.

Only a few of these are acrylonitrile, tetrahydrofuran, acrylic acid and the vinyl ethers. Of course, vinyl chloride and other chemicals are now being made in commercial quantities from carbide acetylene. Acetylene is now finding an exceedingly important use in the manufacture of "PVP," polyvinylpyrrolidone, one of the leading blood volume expanders.

Ethane-Ethylene

Chemicals derived from ethane or ethylene are shown in Fig. 2. Most importantly ethane serves as a raw material for ethylene, which is produced largely from cracking of ethane and propane. Ethylene today stands at the top of the long list of olefinic raw materials. It contributes to nearly twice as many chemicals and classes of chemicals as both propylene and the butylenes.

On the one hand, ethylene can be converted to ethylene oxide, either by direct oxidation or through the chlorohydration process. The oxide can, in turn, be converted to ethylene glycol, monoethanolamine, diethanolamine and triethanolamine, acrylonitrile, synthetic detergents and countless other useful products. In addition to the major utility of ethylene glycol as the base of permanent-type antifreezes, this glycol is just around the corner from major use in another field—that of synthetic fibers. The new fiber, Dacron, is formed from ethylene glycol and terephthalic acid. It has remarkable properties which indicate a great future for it, both alone and in combination with wool and other fabrics. Its outstanding properties are high tensile strength, high resistance to stretching (both wet and dry) and wrinkling, and resistance to fungus mold and mildew. Men's suits made from Dacron-wool combinations are said to require little or no pressing even after washing, a property which makes them very attractive to the consumer.

Acrylonitrile, from ethylene oxide (or acetylene) is also of prime importance in synthetic fibers, since Orlon is made up almost entirely of

Petrochemical Progress

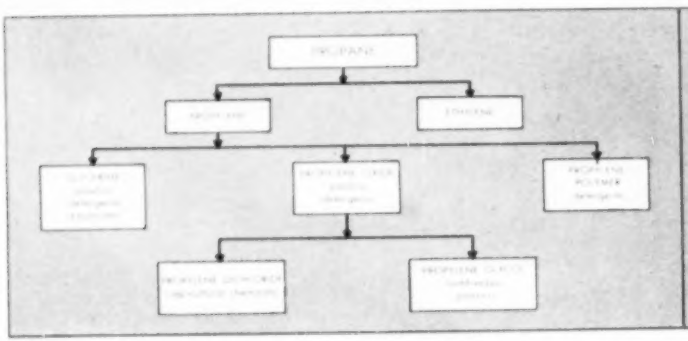


FIG. 3—Propane-derived products

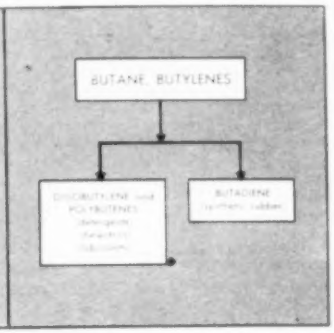


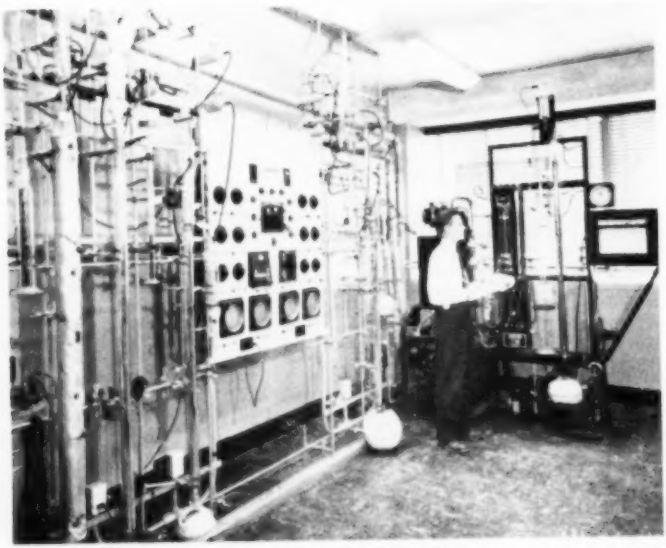
FIG. 4—Butane-derived products

polyacrylonitrile, and Dynel and Acrilan are using increasingly larger quantities of this polymer. In addition, new fibers based on acrylonitrile are now in the development stage. All of the acrylic fibers have almost complete resistance to mildew, moths, fungus and acids, and are stable to sunlight. Although these fibers will be used individually because of their respective properties, their major future outlet may well be in staple form and in mixtures with other fibers, both natural and synthetic.

On the other hand, ethylene can be converted to ethanol, which can be oxidized to acetaldehyde and subsequently to acetic acid. Ethanol production represents the largest single outlet for ethylene. Seventy per cent of the 160 million gallons of industrial ethanol now produced in the United States each year comes from petroleum, and an estimated 75% of the acetic acid is currently derived from this source. Acetic acid and its anhydride contribute in a major way to our economy through their use in the production of acetate rayon and cellulose acetate plastic.

Of the many other uses for ethylene, ethyl chloride, ethylene dichloride and ethylene dibromide for tetraethyl lead manufacture and ethyl-benzene for styrene manufacture may be cited. Lastly, an exceedingly promising use should be mentioned—the polymerization of ethylene to form polyethylene. This new plastic has proved itself in many applications, and we may look for a great increase in its use in near-future years. It is now found in a variety of applications ranging from disposable baby bottles and lollipop sticks to stratosphere balloons and heavy jacketing for telephone cable. It has a number of important individual properties, but it is its combination of properties that mark polythene as truly unique. It has excellent electrical properties, is the lightest of all commercial plastics, has high chemical resistance, is tough and flexible at temperatures well below the brittleness points of other plastics, and has a very low rate of water vapor-transmission. In addition, it contains no plasticizer, is tasteless, odorless, and nontoxic, is available in a wide range of colors, can be heat-sealed, and is easily molded, extruded, and machined. Its relatively low price coupled with its low specific gravity make it an economical material for many uses.

Vinyl chloride, prepared from either ethylene dichloride or acetylene, also forms a useful polymer. It is one of the ingredients of Dynel, a new synthetic fiber. It is also used with vinylidine chloride in the production of Saran, an important highly resistant plastic for use in seat covers, piping, etc.



TYPICAL PETROCHEMICAL LABORATORY: distillation equipment at Jefferson Chemical's Neches plant

Propane-Propylene

Propane-propylene derived chemicals are shown briefly in Fig. 3. A very important use of propane is in the production of ethylene. The three-carbon hydrocarbons, while less important than the two-carbon molecules, have grown in stature significantly since the advent of synthetic glycerine. Propylene undergoes many reactions similar to those of ethylene. For instance, it can be converted to propylene oxide through chlorohydrination. This oxide and the corresponding glycol are finding increasing usefulness in industry. Isopropyl alcohol is derived entirely from propylene, and acetone, a valuable solvent, is manufactured from this alcohol by dehydrogenation.

The chlorination of propylene at high temperatures yields allyl chloride which is being converted to glyc-

erine on a commercial scale. Related products are allyl alcohol (derived from allyl chloride), diallyl ether and acrolein. Acrolein, while formerly made from diallyl ether, has more recently been obtained by the direct oxidation of propylene.

A most important use for propylene forms the basis of a major part of our synthetic detergent industry today. During petroleum refining operations, propylene polymers are produced. The propylene tetramer is used to alkylate benzene to form dodecylbenzene, which is subsequently sulfonated and blended with other materials to produce such detergents as Tide, Fab and Surf. Some propylene trimer also enters the detergent picture as a raw material for nonyl phenol which is, in turn, used in nonionic and anionic detergent manufacture.

Butane-Butylenes

Chemicals currently coming from butane or butylene are shown in Fig. 4. Butane and butylenes contribute in a major way to our economy through their use in the manufacture of butadiene, the major component of GRS synthetic rubber. Current production of butadiene is about 700 million lbs/yr. and stands to increase considerably, even with no all-out war. The nitrile rubbers, which are particularly valuable for their oil resistance, are also derived from butadiene (plus acrylonitrile). Butyl rubber, from isobutylene and isoprene, finds important use in the manufacture of inner tubes. While nitrile and butyl rubbers are produced in small volume compared to GRS, they do represent significant outlets for the C_4 hydrocarbons.

The butylene polymers find limited use in various phases of the chemical industry. Diisobutylene is, among other things, used for alkylating phenol to form octyl phenol. This product is used in the manufacture of lubricating oil additives and synthetic detergents. Triisobutylene and higher polybutenes are utilized as lubricant components, dielectrics, etc.

Aromatics

Aromatics from petroleum are outlined in Fig. 5.

The aromatics — benzene, toluene and xylenes — show great promise for the future as petrochemicals. Benzene is by far the most important member of this group—its production from petroleum sources having only recently been initiated. The National Production Authority and the Petroleum Administration for Defense have recently estimated that 1951 total demand for benzene has been about 252 million gallons. It is further estimated that benzene production from coke-oven sources can increase only from the present rate of 170 million gallons annually to about 200 million gallons.

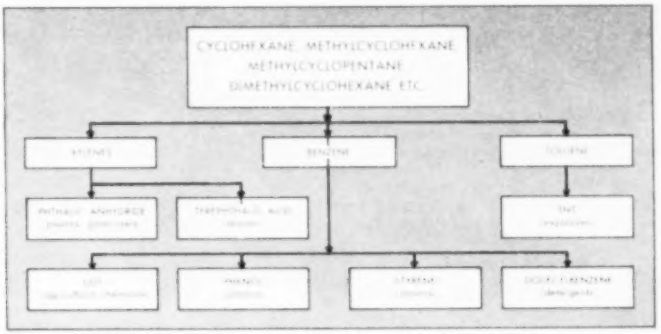
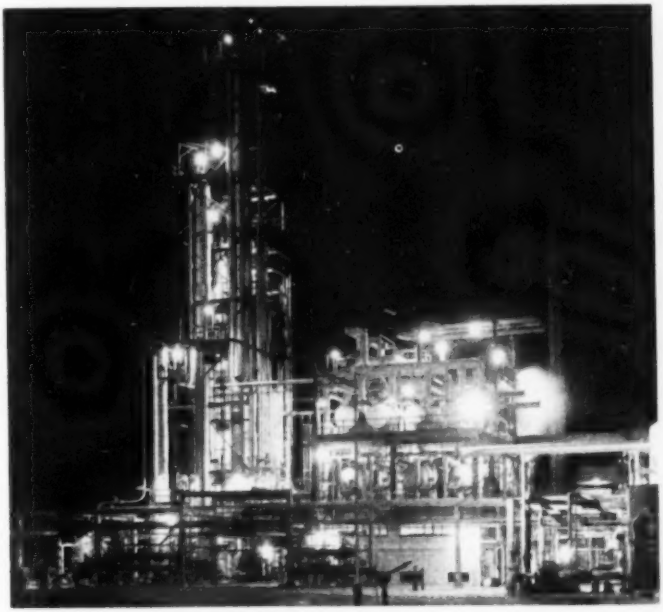


FIG. 5 Aromatics from petroleum

With increased demand forecast, it appears that the present production of around 20 million gallons from petroleum will have to be increased to over 100 million gallons within the next two years and to a projected annual production of as much as 180 million gallons by 1955. The greater part of the current benzene production finds use in reaction with other petrochemicals; i.e., with ethylene to form styrene and with propylene polymer to form dodecyl benzene. Its use as a raw material for phenol, which in turn is necessary for phenolic resins, etc., is a vital part of the chemical picture.

Toluene finds a major chemical use in explosives, and the xylenes are just now becoming of definite, increasing interest in the industry. Orthoxylene can be used to form phthalic anhydride, the meta isomer to form isophthalic acid, and the para to form terephthalic acid. The first two derivatives are important as resin and plasticizer intermediates and terephthalic acid is coming into its own as a raw material for the production of Dacron synthetic fiber.

Brief mention should also be made of cresylic acids, which are extracted from petroleum and which find major use in the production of plasticers such as tricresyl phosphate and as disinfectants. Still other aromatics of



ETHYLENE UNIT at the Neches plant of Jefferson Chemical Co.

some importance in the industry are the petroleum sulfonates, which are inexpensive detergents of use in lubricating oils.

Miscellaneous

Miscellaneous chemicals which deserve some consideration are 1) cyclohexane, which has assumed an important position as an intermediate for nylon manufacture; 2) naphthenic acids, whose heavy metal salts are of significant use as paint dryers, and 3) halogenated petroleum hydrocarbons, produced by halogenation of paraffins.

One of the most important of these is difluorodichloromethane, popularly known as Freon and used as a refrigerant. Other Freons, made from different paraffins and containing varying quantities of fluorine and chlorine atoms, are also used as refrigerants, but perhaps more important, they find use as propellants for aerosol insecticides and in dispensers for aerosol paints, shaving cream and a host of other household products.

Chlorinated derivatives of paraffin wax are finding increasing use in flameproofing, in extreme pressure lubricants, in cutting and drawing oils and in treating textiles to render them water- and mildewproof.

Many of the new insecticides, such as DDT and 2,4-D, are also chlorinated materials derived from petroleum. Although formerly obtained from coal tar, the limitations in that industry have brought about a shift to petroleum as a source.

In any consideration of the long-term future of chemicals from petroleum, the first question which arises in many minds is that of petroleum and natural gas reserves. Fortunately, proven crude oil reserves in this country have actually been increasing due to new discoveries to the point where they are estimated at about 30 billion bbls. Oil is being produced at the rate of 2 billion bbls./yr. and it is expected that more than 70 billion bbls. remain to be produced in the United States.

Oil reserves should therefore be no point of immediate concern to petrochemical people, particularly since at the present time less than 1% of our petroleum production is required for the industry. Also, gas reserves in the Southwest are said to be equivalent to a thirty-year supply at present rates of consumption. There is little doubt that continued extensive exploration will increase both oil and gas reserves markedly in years to come so that the petrochemical industry will be on firm footing. Vast Canadian reserves may well play an important part in this future picture also.

The remainder of the world will ultimately produce at least an estimated 600 billion bbls. of oil, of which only about 8% has been produced. The future availability to this country of this huge reservoir of material, of course, resolves itself primarily into a question of politics rather than one of exploration and techniques.

Cautions and Precautions

A young, rapidly growing industry like the petrochemical industry presents great opportunities for the enterprising individual desiring to start his own business, for the established company wishing to expand, or for the private investor. Nevertheless, while this is indeed a fertile area for the properly trained and equipped, entry into the field must be made slowly and with extreme caution. The large investments needed, the rapid obsolescence of equipment and products, the tremendous utility requirements, the comparatively high product freight rates, the rising raw material costs, raw material depletion at any given location, and the huge sums which must be plowed back into research and development to maintain a competitive position in this rapidly changing picture, are only a few of the obstacles which present themselves.

Meet the Authors

Dr. Neuhaus

Dr. Max Neuhaus, vice president, Jefferson Chemical Co., was born in Schulenberg, Texas. He received his B.S. from Rice Institute in 1927, and following graduate studies at the Technische Hochschule in Berlin, was awarded a Sc. D. by MIT in 1933.

Dr. Sommer

Dr. Neuhaus was a chemical engineer with Humble Oil & Refining Co. from 1927 to 1929. He then joined The Texas Co., where he rose to supervisor of the chemical research division. In 1944, he came to Jefferson as manager, technical and research dept. He was elected vice president in March 1951. During World War II he served, in civilian status, as advisor to the PAW. He is a member of American Chemical Society, American Ass'n. for the Advancement of Science, American Institute of Chemical Engineers, API, Ass'n. of Research Directors, Catalysis Club, and Chemists' Club.

Dr. Nolan B. Sommer, manager, market development division of sales dept., Jefferson Chemical, was born in Merna, Neb., June 27, 1919. He received his B.S. in 1941 and M.S. in 1942 from the University of Nebraska, and a Ph. D. in organic chemistry from Indiana University in 1944.

Dr. Sommer joined American Cyanamid Co. as a research chemist in 1944. In 1947 he came to Jefferson to his present post. He is a member of the ACS, the American Institute of Chemists, the Chemists' Club, and a treasurer of the Commercial Chemical Development Ass'n.

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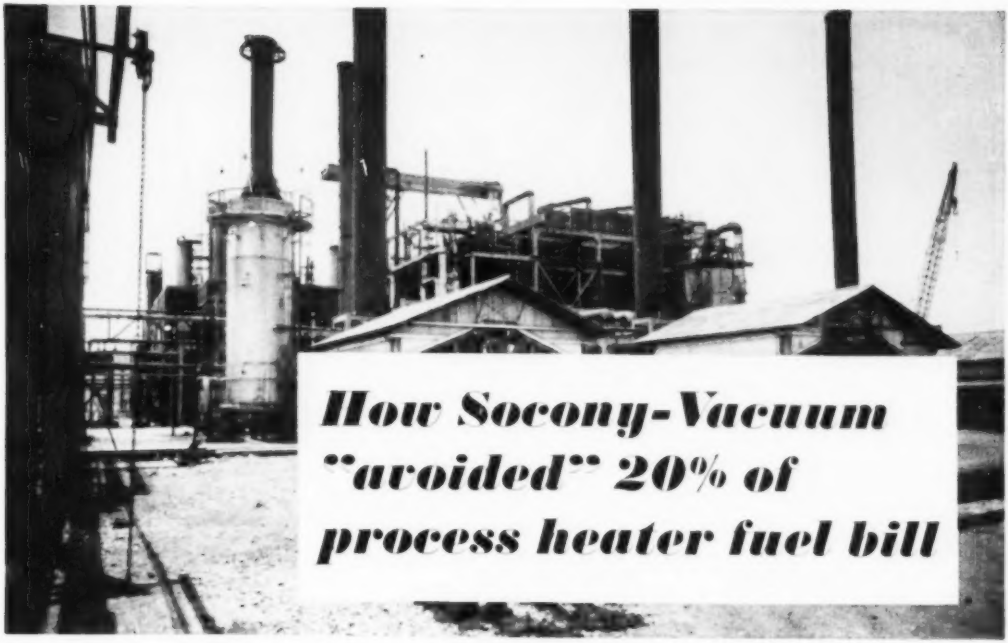

How Socony-Vacuum "avoided" 20% of process heater fuel bill

program →

When engineers at Socony-Vacuum, Trenton, Michigan refinery developed a complete fuel conservation program, process heaters came under close scrutiny. Socony-Vacuum engineers felt they could reduce the total cost of fuel used in raising the temperature of petroleum stock if they could keep the amount of excess air in the flue gases at a minimum.

need →

Socony's instrument engineers wanted an instrument which would indicate excess air, so that they could make adjustments to keep the air at a minimum and thus save fuel.

specifications for instrument →

must provide a **continuous indication** so that changes could be spotted immediately.

must **not be affected by changes in fuel composition** since different fuels are used in the heater furnaces.

must not **be affected by the presence of Hydrogen** in the gas sample.

preferably, measurement should have **direct relationship to excess air.**

selected →

four HAYS MAGNO-THERM OXYGEN ANALYZERS and two HAYS 2-PEN ELECTRONIC RECORDERS

results →

The entire fuel conservation program brought a 20% reduction in Socony's annual fuel bill. The Hays Oxygen Recorders have proved an effective combustion guide on the process heaters.

Improvement in the efficiency of your process heaters can mean large fuel savings. Write for Bulletin 50-829, 16 pages of information on how the O_2 meter works, where it's used, etc. No obligation.

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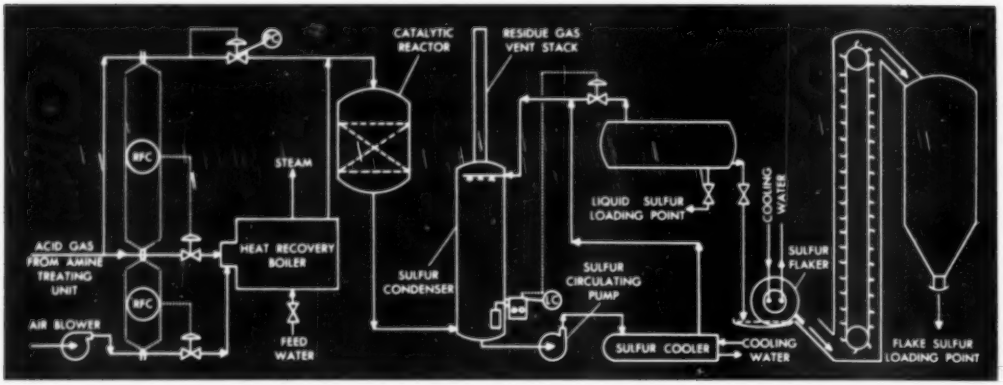
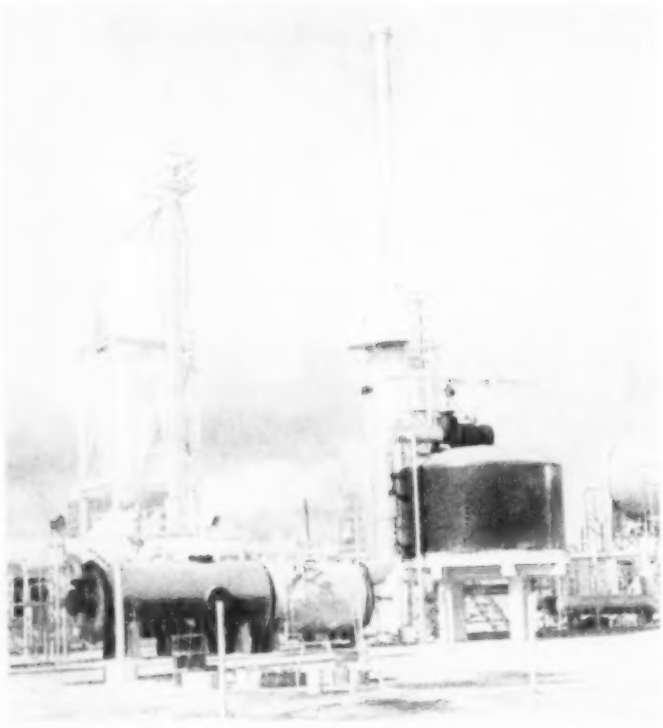


FLOW DIAGRAM of Sid Richardson-Odessa Natural Gasoline automatic sulfur plant

New Sulfur Unit Entirely Automatic

Requires minimum of manpower for operation, converts H_2S into liquid or flake product

By H. H. Jones, Process Engineer
Sid Richardson Carbon Co.
Odessa, Texas



GENERAL VIEW of plant, showing sulfur burner and steam boiler in left foreground, flake sulfur hopper and elevator behind them, catalytic reactor in right foreground, and sulfur condenser, behind reactor

THE first elemental sulfur recovery unit to go into operation in the Permian Basin Area of West Texas was recently placed on stream by the Sid Richardson Carbon Co. and the Odessa Natural Gasoline Co. It is located at the latter's plant site a few miles north and west of Odessa, and has a sulfur capacity of 20 long tons/day.

This plant is a forerunner of several such sulfur recovery units which will soon be in operation in the Permian Basin. There exists in this area a potential source of several hundred tons per day of elemental sulfur to be obtained from hydrogen sulfide as a by-product of various pipe line gas purification operations.

The unique feature of the Sid Richardson-Odessa Natural Gasoline sulfur unit is the completely automatic operation, which makes its comparative small size a profitable operation. This feature permits producing the product and loading it for shipment with only a minimum use of manpower. It likewise is unique in that the sulfur may be produced either in liquid form, for tank-truck or tank car transportation, or as a flaked solid. The latter form is particularly adaptable to products requiring that the sulfur be further processed by grinding to extremely small sizes.

In addition to its value as a producer of an important and valuable basic chemical, this plant also can be

considered as important in conjunction with the elimination of air pollution in the immediate vicinity. The tail gas from the unit is composed predominantly of nitrogen, carbon dioxide and water vapor, all normal constituents of the atmosphere, with only slight traces of hydrogen sulfide. This mixture is far less noxious and objectionable than the hydrogen sulfide, which was formerly vented, or sulfur dioxide produced by flaring waste hydrogen sulfide.

The Process

The acid gas produced by the amine-type desulfurizer at the gasoline plant consists of a mixture of carbon dioxide and hydrogen sulfide. It is therefore necessary to employ a slight modification of the conventional Claus process in order to recover the elemental sulfur.

The hydrogen sulfide and carbon-dioxide-bearing acid gas mixture is divided into two streams. The first consists of one-third of the total quantity of the gas and is burned in the fire box of a steam boiler with the theoretical quantity of air to produce sulfur dioxide according to the following equation:

$$H_2S + 1\frac{1}{2}O_2 \rightarrow SO_2 + H_2O$$

The remaining two-thirds portion of the acid gas is by-passed around the steam boiler and mixed with the products of combustion of the one-third stream in the catalytic reactor, where the following reaction takes place:

$$2H_2S + SO_2 \rightarrow 3S + 2H_2O$$

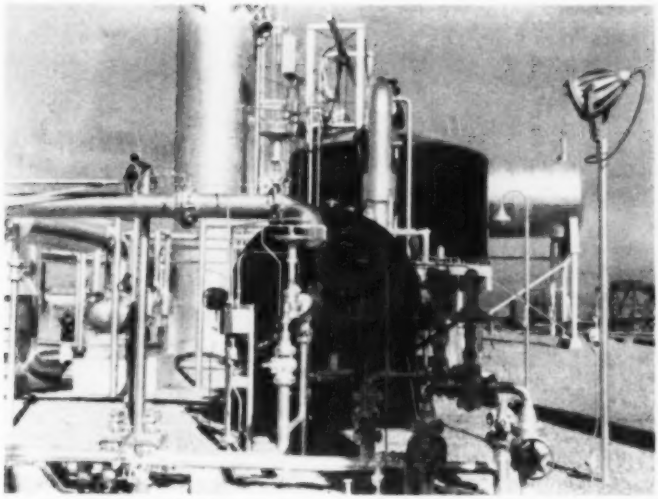
The products of reaction leaving the catalytic reactor, consisting of a mixture of gases and sulfur vapors, are permitted to rise through a sulfur cooler, or "scrubbing tower", where they are contacted with a descending stream of molten sulfur. This stream of sulfur cools the mixture of gases and vapors, condensing the sulfur in the mixture. As the sulfur is condensed, the molten sulfur is pumped from the base of the cooler to an elevated sulfur storage drum. The residue gas, consisting of carbon dioxide, nitrogen and water vapor with traces of hydrogen sulfide, is vented to the atmosphere.

This particular process arrangement permits better temperature control than methods involving combustion of the entire gas stream in the firebox. It also precludes the formation of carbon oxysulfide, which would result from the excessively high temperatures produced by burning the entire stream.

The present operation is giving results which indicate approximately 90% conversion of hydrogen sulfide to elemental sulfur, utilizing only a single stage of conversion.

Sulfur Handling

The molten sulfur is maintained at a temperature of approximately 275° F. in the elevated sulfur storage tank by means of steam coils. In this form it can be shipped for considerable distances in tank trucks or tank cars. For very long distance shipment, in-



SULFUR BURNER, looking at front end. Top line carries combustion air. Line at bottom carries acid-gas, splitting stream into a one-third portion for burner and bypassing remainder to reactor in background

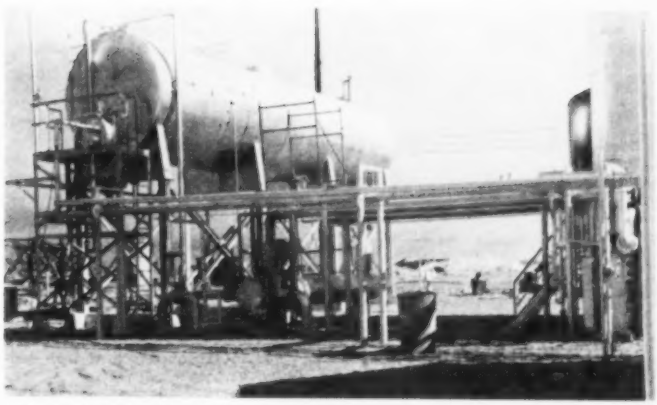
sulated vessels or steam heated tank trucks or tank cars are required, however, liquid sulfur is frequently shipped for as much as 200 miles in winter weather in uninsulated tank trucks. This is possible due to the insulating characteristics of the thin film of sulfur which solidifies on the interior of the tank during loading, and which may be easily melted upon reloading the vehicle.

For further processing to the 200-300 mesh ground sulfur which is essential to the production of insecticides for the agricultural trade, the liquid sulfur is converted to the solid form in small flakes by means of a water cooled flaking drum.

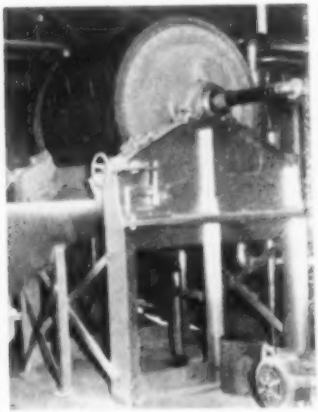
This apparatus consists of a 48-in. by 40-in. cast iron drum which continuously revolves at approximately one revolution per minute with its bottom portion submerged in liquid sulfur.

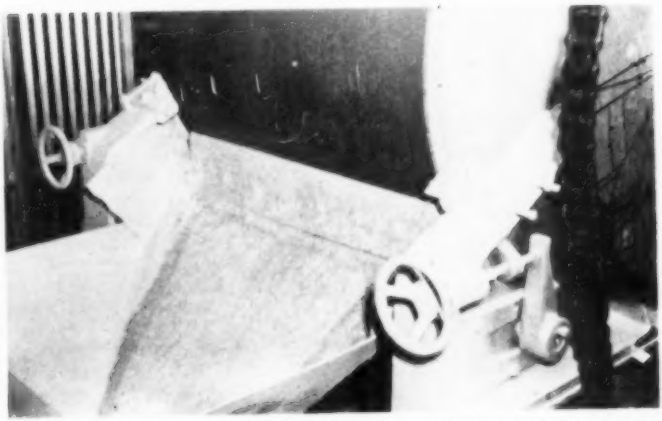
The interior of the drum is cooled by a continuous stream of water and, as the drum rotates, a thin film of liquid sulfur adheres to the surface and is cooled and solidified. As the drum completes its rotation, a stationary scraping knife or "doctor blade" continuously scrapes a layer of solidified sulfur from the surface of the drum, breaking it into small flakes which fall into the boot section of a bucket elevator. The bucket elevator lifts the flaked sulfur into an elevated flaked storage bin, from which it is easily loaded by gravity into trucks.

The drum speed and degree of submergence of the drum can be varied



STORAGE TANK for liquid sulfur, with liquid sulfur cooler below it. Tank is fitted with steam coils to keep sulfur at 275° F.





SULFUR FLAKER, general view at **left**, close-up at **right**. It consists of a large water-cooled rotating drum, partly submerged in pan of liquid sulfur. As drum rotates, thin film of sulfur solidifies on its surface, and is subsequently scraped off by doctor knife, drops into conveyor, and is carried to storage

according to the required rate of production. To prevent shipping losses, it is desirable to produce a rather thick, large flake which does not contain an excessive quantity of dust or "fines."

The sulfur storage bin as well as the feed boot of the bucket elevator are equipped with electric vibrators to insure continuous free flow of the flaked material, and with explosion relief doors as a safety feature.

This flaking operation minimizes the amount of labor required to reduce liquid sulfur to a solid and load it for transportation, and this feature alone is largely responsible for the economical operation of this comparatively small size unit. Inasmuch as the remainder of the operation is practically automatic and requires only casual attention, this sulfur recovery unit is being operated by the same personnel operating the amine gas desulfurization unit.

Utilities

Boiler feed water for the sulfur recovery unit is obtained from the existing gas desulfurization plant system. The sulfur recovery unit produces as a by-product approximately 2 lbs. of steam per pound of sulfur, and this steam is utilized to operate all drives required in connection with the sulfur recovery operation, except for the electric motors that operate the sulfur flaker and the sulfur elevator.

Exhaust steam is returned to the natural gas desulfurization plant system, and is utilized to heat the amine solution reboiler. This reduces the load on the steam generating system of the desulfurization plant and also results in a saving of boiler fuel.

Cooling water required for condensation of the sulfur is obtained also from the desulfurization plant. The hot returned cooling water from the down-stream side of the tube and shell coolers of the desulfurization unit is utilized to cool and condense the sulfur. Cooling water from the sulfur recovery unit is returned to the cooling tower serving the gas desulfurization unit.

Instrumentation and Control

The principal instrumentation of this plant consists of two aneroid type ratio flow controllers, which are employed to continuously apportion the one-third - two-third gas streams and the correct air-hydrogen sulfide mixture for combustion in the boiler. These ratio flow controllers can easily be adjusted, if necessary, to compensate for changes in metering pressures, gas composition, water saturation, or the fluctuations in air density due to changes in ambient temperature and barometric pressure. During normal operation in which acid gas is supplied at a continuous rate and at a constant temperature and pressure, little or no readjustment of controls is required.

An eight-point thermocouple-type temperature recorder is utilized to record important process temperatures, and a temperature recording controller is used for controlling the quantity of cooling water to the sulfur cooler in order to maintain the liquid sulfur leaving the sulfur cooler at the optimum temperature, and in order to prevent freezing of the liquid sulfur in the cooler.

Highly critical materials were not necessary in the construction of this plant. With the exception of stainless steel mesh which covers the cast iron catalyst support grate, all material is ordinary carbon steel.

Routine plant process control tests are carried out primarily with the Orsat apparatus. This apparatus is the same as that long familiar to all operating engineers, with the exception that mercury is used as the confining solution rather than water, since the hydrogen sulfide and sulfur dioxide present at certain stages of the process react with water to produce inaccurate readings.

The most important control test is to be certain that a minimum amount of oxygen is present in the residue gas. Absolute absence of oxygen is not desirable, and neither is an undersupply of oxygen, as reducing conditions tend to cause carbon formation or "coking" on the catalyst.

A chromic acid solution in concentrated sulfuric acid is used for determination of the amount of sulfur dioxide in the boiler flue gas; carbon dioxide is determined by caustic potash solution, and oxygen by use of alkaline pyrogallol solution. In addition to analyzing the products of combustion from the boiler, the residue gas from the unit is also analyzed to determine total remaining hydrogen sulfide and sulfur dioxide content.

Where it is necessary to separately determine the quantity of sulfur dioxide and hydrogen sulfide present, a metered quantity of gas is absorbed in ammoniacal cadmium sulfate solution and the precipitate is filtered, washed and titrated with iodine solution for hydrogen sulfide. Sulfur dioxide in the filtrate is oxidized to the sulfate and can be determined volumetrically by conventional methods.

This sulfur recovery plant is a joint operation of the Odessa Natural Gasoline Co. and the Sid Richardson Carbon Co. Process design and engineering was carried out by the Graff Engineering Co. of Dallas, and erection was carried out by the field construction forces of Sid Richardson.

ANACONDA Arsenical Admiralty

a practical solution to tube dezincification

What causes dezincification?

Metallurgical research indicates a number of conditions causing dezincification of condenser and heat exchanger tubes:

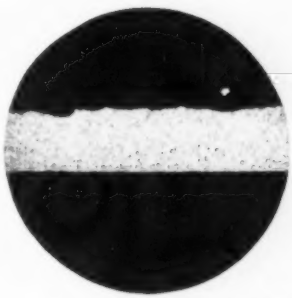
LAYER TYPE dezincification tends to be the result of a critical degree of acidity of the cooling water.

PLUG TYPE dezincification is more apt to occur where the cooling water is neutral or alkaline.

LOW WATER VELOCITY may accelerate the loss of zinc by failing to wash away copper salt solutions, thereby permitting redeposition of copper.

HIGH COOLING WATER TEMPERATURES hasten over-all corrosion reactions and seem to favor the electrochemical process causing redeposition of copper.

LOW OXYGEN CONTENT of cooling water is also considered a factor in accelerating the redeposition of copper.



Longitudinal section through wall of non-Arsenical Admiralty tube showing dezincification of entire wall. 7×

Longitudinal section through wall of non-Arsenical Admiralty tube showing dezincification plug starting from outside to inner surface. 7×

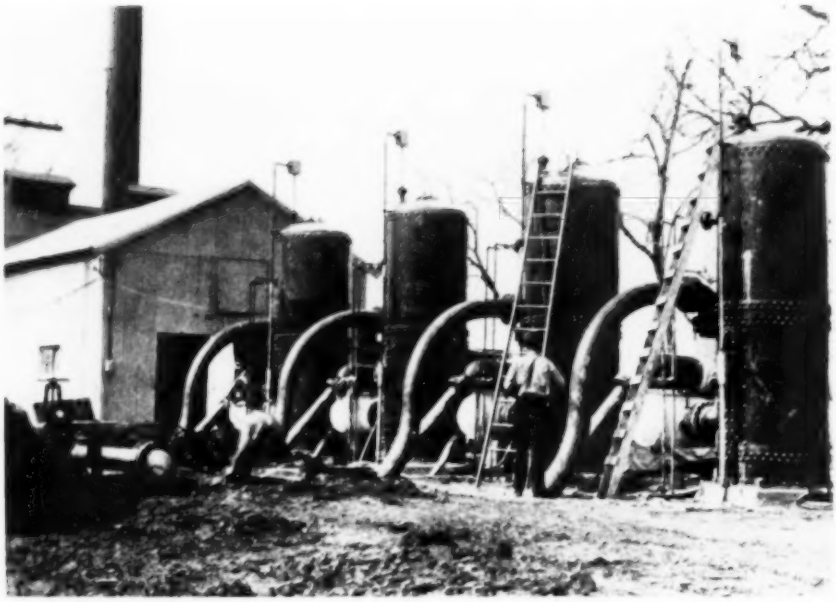
Arsenic as an Inhibitor

Laboratory studies and field installations have clearly indicated the effectiveness of small quantities of arsenic in Admiralty and other copper alloys as an inhibitor to dezincification. The inhibiting action of arsenic, as well as of other inhibitors, is not well understood. One theory holds that the inhibitor covers anodic areas to prevent initial selective corrosion; another states that it forms a film of an electropotential equal to that of the copper to prevent the copper redepositing.

For Technical Counsel

The files of Anaconda's Technical Department and the experience of its engineers cover the case histories of condenser and heat exchanger tubes operating under the widest variety of conditions. These are freely available to you to help you select the right alloy for your installation. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

for efficient heat transfer **ANACONDA** **HEAT EXCHANGER TUBES**



ORIGINAL PLANT of Cities Service Oil Co. at Tallant, Okla., for producing oxygenated petrochemicals from natural gas, as it looked in 1927, a year after it was built. Four vertical vessels are catalytic reactors

Petrochemical Patriarch

26-year old "grandpappy" of chemicals-from-petroleum still operating for Cities Service at Tallant, Okla.

THE entrance of oil companies into the manufacture of chemicals, signaling the advent of what are now familiarly known by the generic term "petrochemicals," is not nearly as recent as one might believe. In fact, the "grandpappy" of them all in the Southwest—the Tallant, Okla., plant of Cities Service Oil Co.—is still operating, hale and hearty, at the ripe old age of 26.

The Tallant plant was originally built in 1926 to produce formaldehyde, methanol and related chemicals from natural gas. By its success, and despite grave doubts which many held for it, this operation has paved the way for numerous others, most of which now dwarf it both in size and variety of products manufactured. The doubters had not reckoned with the burgeoning demand for some of its products soon to be created by another infant, the manufacture of phenol-formaldehyde resins. This development jumped the then-saturated market for formaldehyde in short order, while the simultaneous production of "cheap" methanol inspired its use in many new ways.

This venerable petrochemical plant has been enlarged several times since it was built, and additional facilities have been installed for the separation of pure chemicals. In addition, two small crude-chemical units have been built at the nearby Maud and Oklahoma City natural gasoline plants of Cities Service, the product from both being shipped to Tallant for recovery.

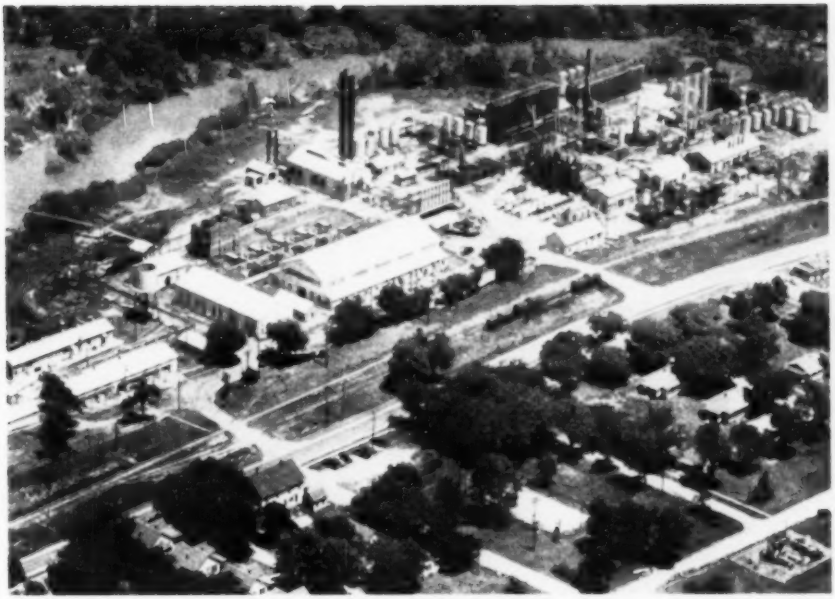
The accompanying aerial photograph of the Tallant installation, although taken in 1946, is its most recent portrait, and there is little change today. The left half of the plant proper is a gas compressor station which boosts low pressure gas into a gas pipe line. The remaining half combines a natural gasoline plant with chemicals production without any precise line of demarcation between the two basic operations. However, in general, the right one-fourth of the entire plant site contains most of the chemical production facilities. The buildings on the near side of the highway include a research laboratory and the company camp.

The development of this pioneer chemicals-from-natural gas plant, like so many other things the oil industry has done, came about quite by accident and might well have been dismissed without further investigation were it not for the curiosity of one John C. Walker. The story goes like this:

About 27 years ago what then was the Star Oil Co., later Empire Oil & Refining Co., and now is Cities Service Oil Co. (Del.), was engaged, among other things, in pumping natural gas from its fields in Oklahoma by pipe line to Chicago. Such severe line corrosion was being experienced that something had to be done. After considerable investigation it was concluded that the principal offender was oxygen, small amounts of which were being sucked into the line along with the gas during the gathering operation.

In an attempt to remove oxygen by promoting oxidation at high temperatures over a catalyst, Walker and associates realized that formaldehyde and methanol, and perhaps other oxygenated hydrocarbons, were being produced rather than oxides of carbon and water. Condensing the combustion products confirmed this suspicion and demonstrated also that acetone and acetaldehyde were present, along with higher alcohols, ketones, aldehydes and water.

It might or might not have been "just luck" that the gas being processed contained, in addition to meth-



TODAY, the patriarch is still going strong at the age of 26. Left half of plant site is gas compressor station, middle fourth is natural gasoline plant, and right quarter is predominately petrochemical manufacture

ane and ethane, small quantities of propane and probably butane. Investigations since have indicated that, had the gas been pure methane, the oxidation might have gone completely to carbon oxides and water, since the intermediate oxidation products are much more susceptible to oxidation than the methane, making control rather difficult.

Perhaps it is an injustice to use that word "luck" in this connection, however, for as early as 1919 Cities Service's founder, Henry L. Doherty, had sponsored investigations into the possibilities of manufacturing chemicals from natural gas and oil. Indeed, it is reported that a pilot plant of semi-commercial proportions was set up in 1920 at the old Empire refinery at Okmulgee, Okla., to produce isopropyl alcohol from cracked refinery gases.

At any rate, careful observations convinced the experimenters that oxychemicals which theory indicated could be formed actually were there in appreciable proportions. Available literature is inferential on this point, but unquestionably there was extensive investigation to determine optimum conditions and catalysts.

In 1926 the patriarch of the petrochemical industry was born. The plant consisted of four reactors together with rather simple fractionation columns and associated equipment beside the compressor house of the company's Tallant gas compressor station, where also was located a small casinghead gasoline plant.

Typical liquid products were found to contain 34-36% methanol, 20-23% formaldehyde and 5-6% acetaldehyde, acetone, dimethylacetal, higher alcohols and water were also present. The catalyst, according to specifications in patents issued during the period 1935-40 to Walker, consists of aluminum phosphate with small amounts of metal oxides. Pressures are in the range of 100 to 300 psi.; temperatures vary from 800 to 900° F.

The oxidation process itself is rather simple. "Wet" natural gas, containing relatively small amounts of propane and butane, in addition to the usual methane and ethane, are preheated by exchange with reactor effluent and brought up to approximate reaction temperature before admixture with a controlled quantity of air (or oxygen) in a reactor. This vessel is packed with the catalyst mixture in a fixed bed. In this connection, air in addition to that originally present in the gas as a pipe line corrosive was required in the original process in order to initiate sufficient reaction to remove all of the objectionable oxygen from the gas stream.

The reactor off-gas then is cooled with incoming gas, and resulting liquids knocked out in a separator. The off-gas is split, part returning as recycle to process and the balance chilled. The condensation products from this operation are combined with those resulting from the first separation to produce a crude mixture of the synthetic chemicals.

In the purification of this mixture, Cities Service again made noteworthy contributions to the chemical field, for such a complex mixture as direct oxidation produces cannot really be separated into its pure components by simple distillation. The unit operations of fractionation, liquid-liquid extraction, vacuum distillation, filtration, adsorption and ion-exchange all are involved to effect the recovery of marketable commodities. At Tallant the first commercial application of ion-exchange, except in the field of water purification, was used to prepare low-acidity formaldehyde needed in resin and plastics manufacture.

Principally, methanol and formaldehyde are commercially produced in approximately equal quantities. Smaller volumes of acetaldehyde, acetone and methylacetone (15% mixture of methanol and acetone) solvent also are recovered.

Published information on the techniques employed is meager, understandable as most of the process conditions reportedly are primarily the result of "know-how" and much experimentation. There likewise is little information on production of the individual components. Latest information available indicates capacity production of oxygenated chemicals by Cities Service Oil Co. is approximately 5,000,000 gal. annually at the present time. In the period 1942-47 actual production is reported as exceeding 150,000,000 lbs. The 1948 report of Cities Service Co. gives chemicals production by its subsidiaries (in this case Cities Service Oil) as 1,253,000 gal., comprising formaldehyde, methanol, acetaldehyde and methyl acetone-type solvents.

The bulk of these materials are used in anti-freeze formulations marketed by Cities Service, the formaldehyde in plastics manufacture and the balance as solvents, some of the latter also being marketed direct by the company under various brand designations.

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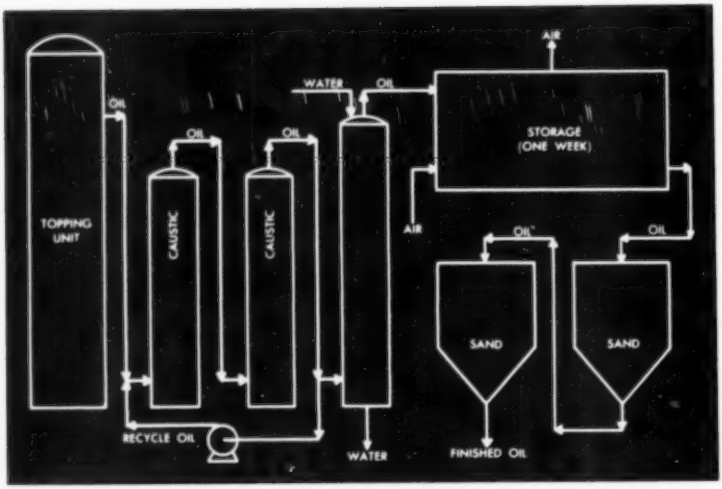


SUGGESTED PROCESS DESIGN for caustic washing distillate oils

Naphthenates from Spent Caustic

There's an additional profit in caustic washing of distillate oils due to naphthenic acid shortage

By MILTON R. BEYCHOK
Pacific Chemical Co.

THE present shortage of naphthenic acids has focused new attention on their recovery in the petroleum refinery. National production of naphthenic acids over the last six years has remained within 25 to 30,000,000 lbs annually, and it has been estimated that the consuming industries can absorb another 12,000,000 lbs during 1952.

The largest end product users of naphthenic acids are the wood preservative and the paint industries. Copper naphthenate is an excellent fungicide for wood and canvas treating. Other metallic salts are very good as paint driers. The use of naphthenic soaps as an ingredient of Napalm offers another large sales outlet.

Naphthenic acids are cycloparaffinic organic acids and usually are monocarboxylic. Some examples of these compounds are cyclopentylcarboxylic and methylcyclohexylcarboxylic acids. Sachanen[1] and Ellis[2] both have extensive information on these acids for those who desire the fundamental chemistry.

The acids occur in crude oils and normally are recovered with the straight-run gasoline and distillate oil fractions of a topping unit. If these fractions are caustic (NaOH) scrubbed, the naphthenic acids are recovered as the sodium naphthenates. The market value of the spent caustics depend upon: 1) the free acid content, and 2) the ASTM acid number (D 974-51T) of the recoverable free acids.

As an approximation, the following data indicates the acid number range of the recoverable acids found in typical topping unit products:

Product	Acid No range
Heavy naphtha	280-320
Kerosene	250-280
Stove oil	220-250
Diesel oil	180-220

The purpose of this article is to present an economic basis for studying the advisability of caustic washing distillate oils in those refineries which normally do not caustic wash. Also presented is a suggested process design for caustic washing distillate oils, and a laboratory procedure for determining the naphthenic acid content of spent caustics.

If the spent caustic (sodium naphthenate solution) is the product sold, it can be shown that a gross profit can be realized ranging from 3.9 to 19.4c gal. of caustic soda used. This depends upon the strength of the caustic soda and the naphthenic acid content of the distillate oil. If acids are to be recovered from the spent caustic, and then sold as acids, an entirely new cost structure must be calculated. The following analysis indicates the development in the case of selling spent caustic.

Cost of the caustic soda varies with the gravity used. Based on 50° Baume gravity caustic at $0.017 lb., which is equivalent to solid NaOH at $0.034 lb., the range is as follows:

Be.	Cost/ gal.	Cost/ bbl.
20	$0.016	$1.94
15	0.032	1.38
10	0.021	0.86
5	0.010	0.42

Sales prices of spent caustics used in this economic analysis are as follows: acid number 140-179, $0.03 lb. of acid content; 180-219 acid number, $0.04 lb.; and 220-249, $0.06 lb. These prices are not to be construed as going market prices. However, they are sufficiently accurate for this purpose.

The gross profit analysis is covered in Table I. Attainable naphthenic acid recovery, assuming 100% of the NaOH reacts to form sodium naphthenates, is shown in Columns 3 and 4. By definition of the acid number, the equivalent weight of the naphthenic acids is 56,000/(acid number).

However, the upper limit of conversions as encountered in plant

scale operation is more usually about 50%. The gross profit analysis, based on a 50% conversion of the available NaOH reacting, is shown in the same Table 1, Columns 5, 6, 7, and 8. It can be seen, for example, that 15° Be. caustic used to recover 200 acid number products will yield a gross profit of $0.107 (10.7c) per gallon of caustic used. Caustic of 20° Be will yield a profit of $0.154 (15.4c) on 200 acid number products. With lower gravity caustic, profits will decrease as indicated.

Caustic washing of distillate oils will improve product color, yield a product with a storage-stable color and an extremely low acid number, as well as recover sodium naphthenate. A suggested process design is shown schematically in the flow diagram.

Essentially, the process is a batch caustic scrub followed by a continuous water wash. At this stage, the oil has a haze caused by entrained sodium naphthenate in an aqueous phase. Adequate storage time with continuous air blowing, followed by sand filtration, yields a clear, light-colored, stable oil of low acid number.

The warmer the oil, the easier the process. Hence, treating in the rundown line at a temperature of 150-175° F. should be satisfactory. If the oil is charged from storage, then suitable heating must be provided. The throughput rate should be kept as constant as possible to counteract changes in topping unit throughput. A recycle pump is provided for this purpose. For example, if the topping unit slows down, recycle rate is increased. Operational experience will indicate the optimum throughput rates.

Two scrubbing towers are provided for caustic, with suitable manifolding to allow cyclic operation—changing caustic in one while the other is on stream. Oil inlets in the towers should have distribution "spiders." Tower packing is not particularly necessary.

Tower sizing must be on the basis of 1) naphthenic acid throughput, and 2) the desired interval between caustic changes. Knowing the oil rate and the naphthenic acid content of the oil, the acid throughput rate is calculated. From the data in the cost analysis just described, and assuming 50% efficiency, the amount of caustic required can also be calculated. Water washing requirements are limited only by economic considerations—water availability and costs. The more water washing, the better.

Prolonged intermediate storage—at least one week—is highly desirable. If a blower is available, it is very likely that sufficient air blowing can eliminate the haze without need of subsequent sand filtration.

Final "polish" is achieved by down-flow filtration through sand. Two sand beds are provided with adequate manifolding to permit cyclic operation and changing of sand while on stream. The sand is supported by a lower layer of coarse crushed rock, or clay, which in turn is supported by a perforated retaining ring. A sand of the following mesh analysis is recommended: 15-mesh size, 22% retained; 20-mesh, 58% retained; 24-mesh, 12%; 30-mesh and over, 8%. This should be capable of clarifying approximately 2000 bbl. of oil per ton of sand. This value is on the conservative side and may be safely used to size the sand beds.

Table 1—Attainable Acid Recovery and Gross Profit Analysis

(1) Baume Gravity	(2) Naphthenic Acid No.	(3) Naphthenic Acid Recov. lb gal NaOH*	(4) Naph. Acid Content of spent caustic Vol.-%	(5) Naphthenic Acid Recov. lb gal NaOH**	(6) Cost of 1 gal. NaOH	(7) Income from Naphthenics	(8) Gross Prof. per gal. of NaOH
20	150	13.22	82	6.61	$0.046	$0.198	$0.152
20	200	9.93	55	4.98	0.046	0.200	0.154
20	250	7.94	50	3.98	0.046	0.240	0.194
15	150	9.24	58	4.62	0.032	0.138	0.106
15	200	6.95	47	3.48	0.032	0.139	0.107
15	250	5.55	41	2.78	0.032	0.167	0.135
10	150	5.80	42	2.90	0.021	0.087	0.066
10	200	4.32	35	2.17	0.021	0.087	0.066
10	250	3.48	30	1.74	0.021	0.108	0.087
5	150	2.70	25	1.35	0.010	0.041	0.031
5	200	2.03	20	1.02	0.010	0.041	0.031
5	250	1.63	17	0.82	0.010	0.049	0.039

* Assuming 100% of the NaOH reacts. By definition of acid number, equivalent wt. of naphthenic acids is 56,000/Acid No.=

** Based on 50% of the available NaOH reacting; half of value in Column (3).

Acid Content Analysis

The procedure for the determination of the vol-% of naphthenic acids in spent caustic is for crude acids without water and neutral oil removal. Apparatus required includes: a Babcock type centrifuge bottle (Central Scientific Cat. No. 27345A, Cat. J-150); a 10-ml. pipette; a water bath at 150-175° F. (or oven at the same temperature); and a centrifuge. Reagents needed are: approx. 50% (vol.) H_2SO_4 and methyl orange indicator solution. Procedure is as follows:

1. Shake sample container well and pipette out a 10-cc. sample.

2. Wipe off the exterior of the pipette and drain into the Babcock centrifuge bottle. With highly viscous materials, it may be necessary to wash another 10-cc. of distilled water through the pipette into the bottle.

3. Add 3 to 4 drops of methyl orange indicator solution.

4. Add H_2SO_4 until the sample is neutralized to the methyl orange end point. The sample will attain a white, milky appearance as the end point is approached. When the end point is reached, and the naphthenics rise to the top, the sample will become relatively clear. The methyl orange is usually bleached out and more must be added to confirm the neutralization.

5. Add hot water (about 180° F.) in small increments until the upper meniscus is between the 90 and 95 marking on the bottle neck. Swirl the sample between water additions (do *not* shake and do *not* invert).

6. Heat at 150-175° F. for one hour and then centrifuge for at least 15 minutes.

7. Read the naphthenic acid layer directly in vol-%.

8. If the naphthenic acid layer is not fairly translucent, more heating and/or higher rpm. centrifuging is in order. If this does not help, then the reading must be estimated as closely as possible.

If the naphthenic acid percentage is very small (less than 5%), it is advisable to use a 20-cc. sample. In that case, divide the final reading by 2. Using a hot solution of sodium sulfate to increase the density of the water layer may help in obtaining a clear upper layer when a particularly difficult emulsion results.

Meet the Author

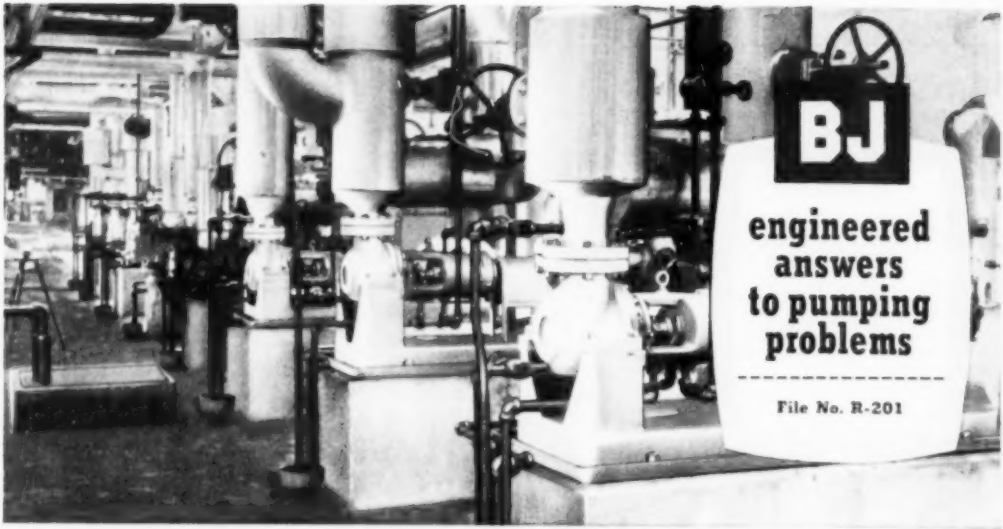
Milton R. Beychok is associated with Pacific Chemical Co., a new California firm presently being organized. He is also chief chemist, Rothschild Oil Co., Santa Fe Springs, Calif., and engaged in consulting work in process design calculations. No newcomer to the pages of PETROLEUM PROCESSING, he has contributed previously to the Laboratory Practices section.

His schooling was interrupted by four years of military service in the Field Artillery, U. S. Army, and he was graduated from Texas A. & M. in 1947 with a B.S. in Chemical Engineering. He then became associated with Shell Oil, and worked as a research engineer until 1949, when he joined Rothschild.

References

(1) "Chemical Constituents of Petroleum," Sachanen, 1945, pp. 315-329.

(2) "Chemistry of Petroleum Derivatives," Vol. 1, Ellis, 1934, pp. 1062-81.



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- Fresh feed capacity—6,000 bbl. per stream day of gas oil, operating at approximately 55 per cent conversion level.

No. of Units	Type of Pump	Capacity	HP	Application and Product Handled
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1	3x4x8 H SM Process	310 gpm	20	Quench Oil Pump—Handles 650°F cycle oil
5	2x3x11 L Fig. 1050	100 gpm	30	Fractionator Reflux and Absorber Charge and Stabilizer Reflux Pumps with Type "U" Mechanical Seals
1	2x3x12½ H SM Process	110 gpm	40	Flasher Bottom Pump — Handles 725 °F Residuum
1	3x4x8 L SM Process	180 gpm	10	Re-boiler Oil Pump — Handles gas oil
2	1½x2x8 H SM Process	45 gpm	5	Catalytic Poly Stabilizer Reflux Pump — Handles Butanes (Pumps have Type "U" Mechanical Seals)
1	1¼ TLM Bilton	30 gpm	5	Poly Reactor Wash Pump — Handles water
2	24 KXH Vertical Circulating	6000 gpm	250 and Turbine	Cooling Tower Pumps — Handles Cooling Tower Water for entire plant (Turbine drives through Philadelphia Right-Angle Gear)
2	1½ TLM Fig. 1025	105 gpm	2	Top and bottom Absorber Intercooler Pumps — Handles light hydrocarbons (With BJ Type "U" Mechanical Seal)
1	2x3x12½ H SM Process	64 gpm	30	Recycle Pumps—Handles recycle oil
1	3x4x8 H SM Process Pump			These pumps are used as common spares for the above services.
1	2x3x12½ H SM Process Pump			

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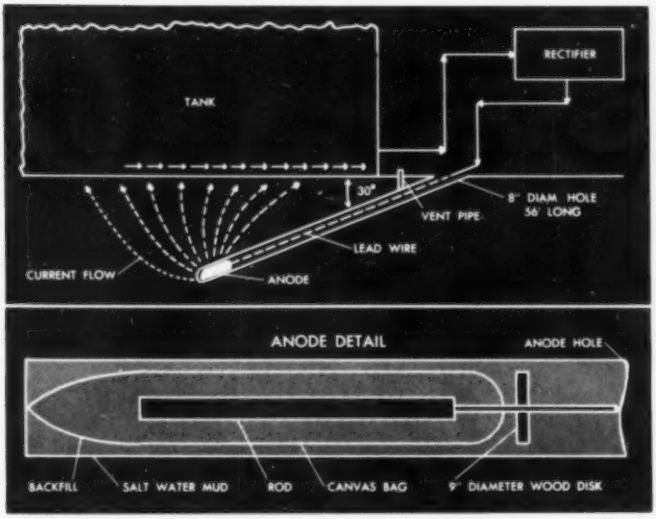

CATHODIC PROTECTION SYSTEM as used on 12 oil storage tanks—general arrangement and detail of anodes

Stop Tank Bottom Corrosion With Cathodic Protection

ONE of the most practical methods of retarding corrosion on metal structures buried in the soil or submerged in the water has been the use of cathodic protection. Used to the greatest extent on oil pipelines, the method involves application of electric counter-currents flowing continuously to the structure being protected.

Its use was described recently for protecting 12 large oil storage tanks in a refinery on the West Coast.[1] With an installation cost of $1500 per tank, and relatively low operating requirements, the company was well satisfied with the system.

Basic to all proper corrosion control techniques of this type is the determination of true potentials. Sufficient current must flow from the soil to the structure to maintain a constant voltage of 0.85 or more between the structure and a copper sulfate electrode in contact with the soil.

The storage tanks involved were 80,000 and 100,000 bbl. capacity, all some 25 years old. Leaks had developed in the bottoms of several, and a new bottom had to be installed in one. The corrosion was all external and not always uniform. The points of severest attack were where the roof support columns connected with bottoms, and around the outer rim from the perimeter inward for a band about 15 ft. in width. These are locations of good contact with the soil.

Patches were cut out of the bottom at approximately 40 locations, for inspection and to make rod resistance tests. Soil resistance increased from the rim to the center of the tank in some cases resistance at the perimeter was 500 ohms cu.cm. less than at the center.

One 80,000-bbl. tank was used for experimental purposes. Connecting piping was insulated electrically at the flange joints. Foam lines were insulated with armored insulating couplings. The first test was to use five graphite anodes, 2 x 80-in. rods, with graphite backfill. They were spaced equally in a ring around the tank and 60 ft. from its perimeter. Soil resistance ranged from 1500 to 3000 ohms/cc. Current of 10 amps was applied at the anodes. Tests at a number of locations on the tank perimeter after several days showed potential to be 0.12 to 0.15 volts. Then an 8-in. horizontal hole was drilled one ft. below the tank bottom and running to the center. As it was drilled, potential tests were taken at approximately 10-ft. intervals. At the first 10-ft. interval from the perimeter, potential did not drop very much, but from there on to the center, it dropped evenly, and was 0.69 volts at the center.

In a second test, an old, un-used, buried pipeline about 300 ft. from the tank was tried out as an anode. Current of 10 amps, was applied and then increased gradually for several weeks. At 28 amps, the potential at the perimeter was 2 volts and at the center was 0.8 volts.

The third test resulted in the method finally adopted. Five holes, 8 in. in diameter and 56 ft. long were drilled under the tank at an angle of 30° to the ground level and starting just beyond the tank perimeter. They were spaced equally around the rim. Graphite anodes, 2 x 80 in. were placed in the holes with graphite backfill, and then backfilled with soil mixed with salt water. (See drawings)

Current of 18 amps was applied, and after 24 hrs. potential at the perimeter was 1 and at the center was 0.85 volts. The set-up was operated for 2½ years, at which time the tank was opened up for a clean-out, and ten patches were cut out of the bottom for inspection.

The metal showed no indication of active corrosion and all the old pits were inactive. The anodes were operating at approximately their recommended capacity and the resistance from anodes to remote earth had not changed.

With this information, it was decided to protect nine 100,000 and three 80,000 bbl. tanks, all in one area and spaced approximately on 350 ft. centers. Surface soil resistance varied from 250 to 3000 ohms/cc. Most of the connecting piping was in trenches or on top of the ground, although some of it was buried in the earth fire-walls. No attempt was made to protect the piping. The 80,000-bbl. tanks had approximately 11,000 sq. ft. of bottom each, and the larger tanks about 14,000 sq. ft. each, making a grand total of 159,000 sq. ft. of surface to be protected. Four rectifiers were installed, one for the three smaller tanks, and one rectifier for each three of the larger ones.

Five 2 x 80-in. anodes were installed under each 80,000-bbl. tank and eight under each larger tank. They were made into package units, the anode being placed inside a thin canvas bag, 6½ in. x 10 ft., with a foot of graphite backfill at each end. Before the anodes were put in the

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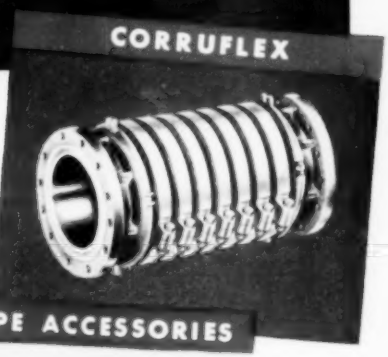

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holes a salt solution was sent down by hose and allowed to soak into the soil.

Following placing of the anodes, screened soil was mixed with salt water into a thin mud; a 2-in. hose was run down the hole to the top of the anode and mud forced around the anode with compressed air. The holes were backfilled for about 2 to 3 ft. on top of the anodes, but the balance of the holes were not filled. At the top of each hole, a piece of ½-in. pipe, 5 ft. long, was placed with its upper end 4 in. above grade. Then the holes were sealed off with brick and soil. This vent permitted the chlorine to escape to eliminate gas locking of the anode. The soil was very hard—sand and clay—and did not cave in. The anode leads were run to small water-tight connection boxes located on the concrete ring outside the perimeter of the tank; connections were made to main feeder wires in the boxes.

Anodes for the 100,000-bbl. tanks averaged 2.41 amps. per anode; those for the 80,000-bbl. tanks, 1.67 amps. It was estimated that the salt—300 lbs. per anode—would last 20 to 25 years with a dissipation of 3.5 amps. per anode (information from the anode manufacturer). It required 1.38 milliamps per sq. ft. to protect the 100,000-bbl. tanks and 0.76 m.a. sq.ft. for the smaller tanks. Potentials for the 12 tanks averaged 1.1 volts with a minimum of 0.924.

The connecting piping was all insulated from the tanks. Resistance shunts had to be installed across some of the joints to restore original potential. The rectifiers were oil-cooled, vapor and water-tight, with a capacity of 30% more than the required current and 20% more than the required voltage.

Power consumption per tank per month for the 100,000-bbl. tanks was approximately 410 kw. and for the smaller about 88 kw. Average line voltage at the rectifiers for the 100,000-bbl. tanks was about 14.3 and for the smaller about 7.

(1) "Cathodic Protection" by L. A. Snyder, consulting engineer, Calif.—California Natural Gasoline Ass'n., Fall Meeting, 1951, Los Angeles.

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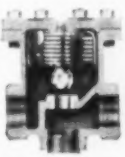
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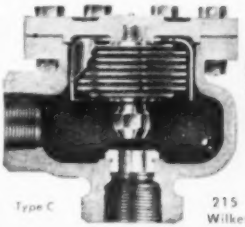
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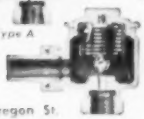
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The solution flows by gravity from the feed vat through a check valve into the pressure pot. At selected intervals, air pressure forces the solution through the discharge line to the water to be treated. The volume of solution discharged from the pressure pot may be varied by raising or lowering the outlet line through a stuffing box.

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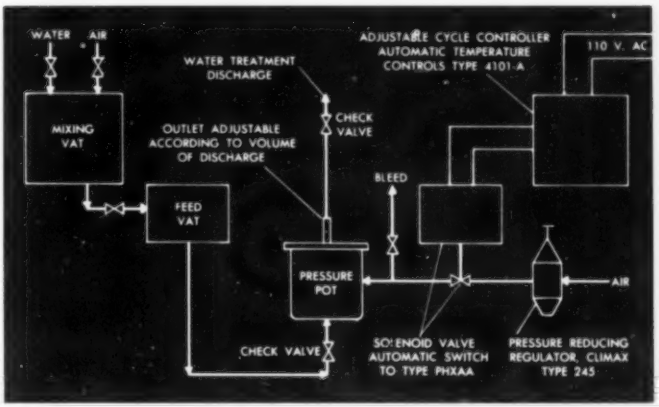


Above is based on an idea from "Operating Kinks" session of Oct. 1951 meeting of NGAA, Tyler, Texas, by Charles W. Miller, Midland Gasoline Co., Conroe, Tex.

Magnet Traps Metal, Aids Fluid Unit Repair

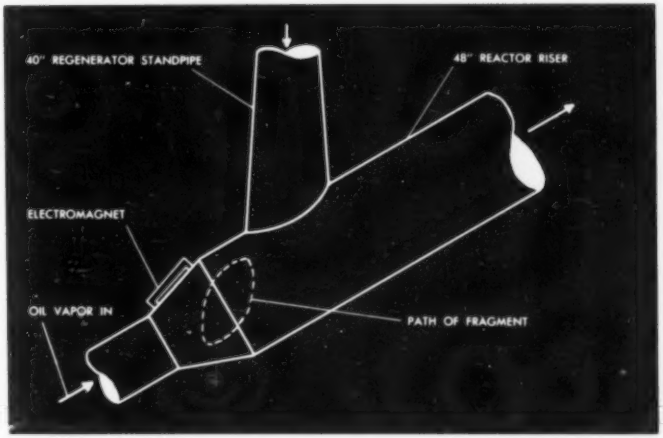
By LEWIS N. DAWSON*

SHORTLY after Sinclair's annual turnaround a large metal fragment, presumably a section of regenerator grid, broke loose in the Fluid catalytic cracking unit. It lodged at the intersection of regenerator standpipe and reactor riser. It then began a cyclic motion from one side of the duct to the other. At this point the duct consists of a conical steel segment, 1 in. thick, lined with hex steel.

A decision was made to temporarily trap the object to prevent further damage to the duct lining. While it was trapped, shaped reinforcing plates had to be welded around the cone and adjacent duct work. To do this a 45 in. diameter all welded lifting magnet was obtained from the refinery salvage department. The magnet had been used to load scrap. The magnet and its 230 volt DC generator were transported to the Fluid catalytic cracking unit, where the duct insulation was removed and the magnet was placed against the duct.

For eight days the magnet trapped and held the object without difficulty. Experimentation revealed that 2½ in. magnesia block insulation could be placed between the magnet face and the duct without seriously weakening the field. The magnet was further protected against the duct's 1000° F. heat by water sprays and forced air circulation.

The magnet was shifted several times to allow the reinforcing plates to be welded to the cone. After the job was completed, a check by electricians revealed that the magnet had sustained no damage during its strenuous service. After being freed from the magnetic field the metal fragment was gradually worn out.



* Mr. Dawson is a mechanical engineer in the Sinclair Refining Co. Marcus Hook, Pa., refinery.

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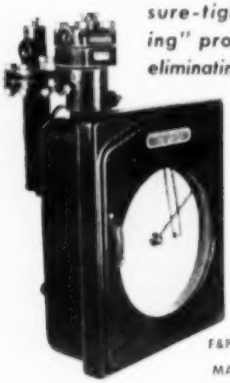

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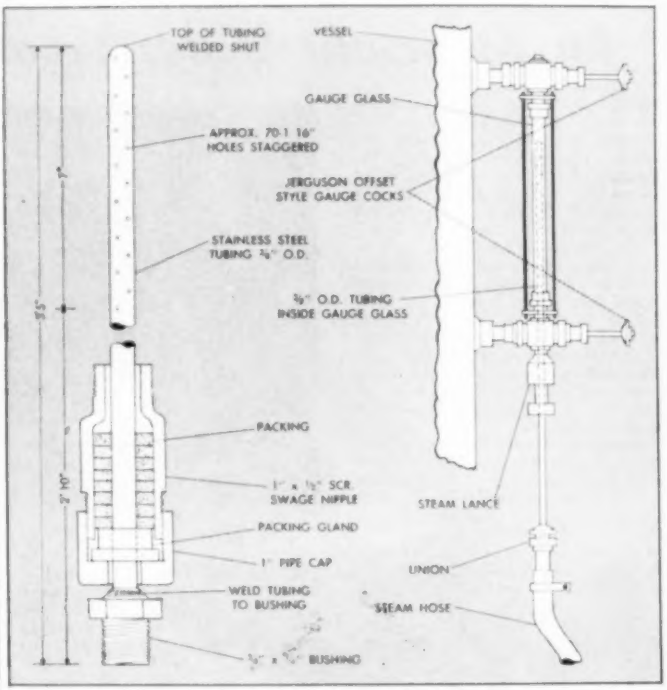


STEAM LANCE for cleaning out gage glasses, shown in detail

How to Clean Out Gage Glasses

COMPLETE dismantling of liquid level gages on vessels for cleaning the glass tubes is no longer necessary at the East St. Louis, Ill., refinery of Socony-Vacuum Oil Co., Inc.

The job can now be done with the steam lance device illustrated in the drawing above. The lance consists of a metal tube, 41 in. long by ⅜ in. in diameter, drilled with approximately 50 holes, each one ⅛ in. in diameter.

Fitted with a stuffing box at one end, the device can be inserted in almost all high pressure, high temperature gage glasses to remove the coke and other accumulations which prevent accurate observation of level. Best results are obtained by running steam at 175 psi. through the lance.

The gadget was developed by Lee J. Frecant of the East St. Louis refinery and turned in to the Socony-Vacuum suggestion system.

How to Save on Pump Repairs

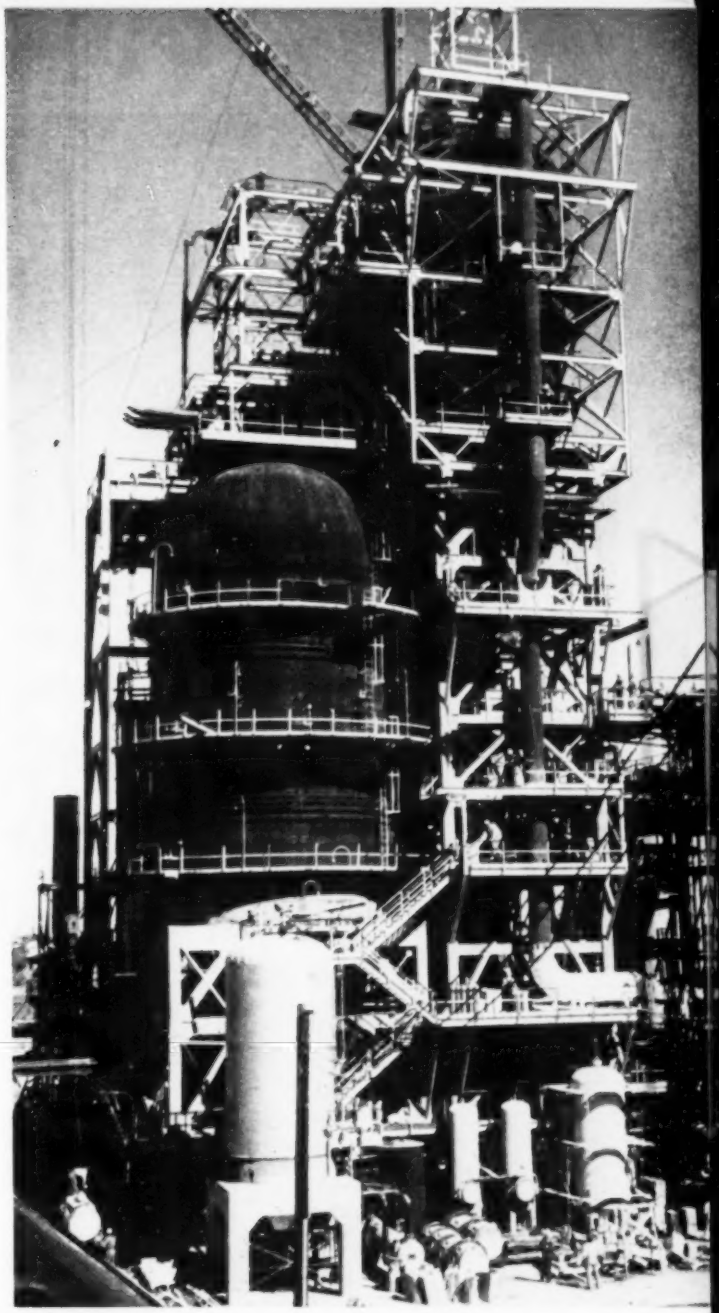
EVERY time the head was removed from a hot oil pump at the Philadelphia refinery of Atlantic Refining Co., maintenance personnel had a problem with the flange nuts. The wrench supplied with the pump was too weak in the jaws and they would spread. There was not enough room to get an adequately strong wrench between the pump case and the nuts. About the only thing left to do was have a second man hold the nuts back with a spud bar.

The solution was a retaining ring, fabricated from 36 x 44 x ¾ in. boiler plate steel. A total of 28 hexagonal holes to fit the 2¼-in. hex nuts was burned out in the ring, evenly divided around the bolt circle. The ring was then cut into four sections and tack-welded to the back of the flange on the pump case.

Nuts are now held securely, gaining all the power available from the impact tool in tightening the bolts, and eliminating the need for the extra man. A saving of $12.78 is estimated on each job.

(To obtain more data on advertised products see page 696)

NEW PACIFIC COAST FLUID CAT CRACKER



THIS new 28,500 B/D Fluid Catalytic Cracking Unit nearing completion at Wilmington, California, is being built by Arthur G. McKee & Company for the Union Oil Company of California.

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

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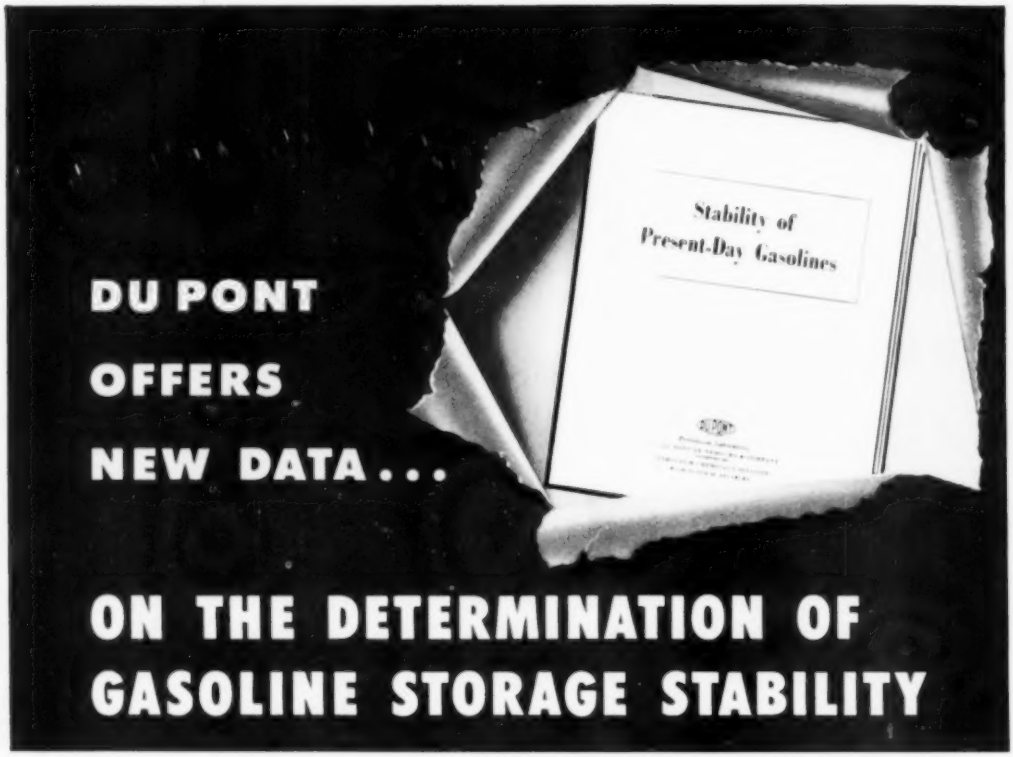
District Engineering Offices: Union, New Jersey and Tulsa, Oklahoma



DO ACCELERATED TESTS accurately measure the stability of modern catalytic-cracked gasolines when subjected to long-time storage?

There has been a growing feeling among refiners that induction period tests do not give as satisfactory results when applied to present-day gasolines as they did with earlier fuels. To evaluate the significance of accelerated tests, the Du Pont Petroleum Laboratory recently made a comprehensive study of the problem.

THE RESULTS of this work indicate that tests conducted at different temperatures do not necessarily correlate with each other. This lack of correlation appears to be due to differences in temperature sensitivity of the gasolines tested. But it is possible to develop a correlation for a specific stock provided the types of additives are not changed.

The tests also indicate that Du Pont Metal Deactivator provides much greater storage stability than is predicted from accelerated tests . . . and that the relative effectiveness of gasoline antioxidants in storage cannot be accurately predicted by these tests.

COMPLETE DATA from the Petroleum Laboratory's tests are available to refiners in a paper entitled "Stability of Present-Day Gasolines." For your copy, contact the nearest Du Pont Petroleum Chemicals Division district office.

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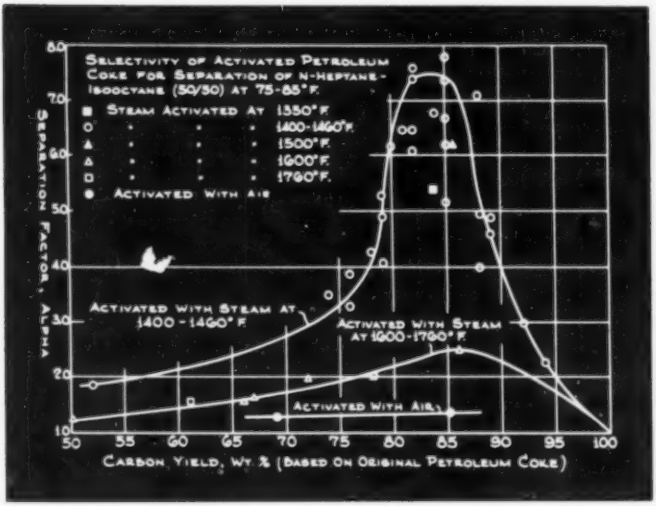
IN CANADA: Canadian Industries Limited—Toronto, Ont.—Montreal, Que.—Calgary, Alta.

By Peter J. Gaylor, Patent Attorney, Gaylor, Cifelli & Jurick, Newark, N. J.


SELECTIVITY OF ACTIVATED PETROLEUM COKE FOR SEPARATION OF N-HEPTANE-ISOOCTANE (50/50) AT 75-85° F.
STEAM ACTIVATED AT 1350° F.
1400-1460° F.
1500° F.
1600° F.
1700° F.
ACTIVATED WITH AIR
ACTIVATED WITH STEAM AT 1400 - 1460° F.
ACTIVATED WITH STEAM AT 1600-1700° F.
ACTIVATED WITH AIR
SEPARATION FACTOR, ALPHA
CARBON YIELD, WT. % (BASED ON ORIGINAL PETROLEUM COKE)

ADSORPTION CURVES for variously treated petroleum cokes with n-heptane isooctane mixtures (U. S. 2,586,889)

Activated Petroleum Coke Found to Have Unusual Selective Adsorption Properties

IN ONE of our earlier articles (PETROLEUM PROCESSING 8/48, p. 787) we discussed some patents issued to Prof. Barrer and Standard Oil Development Co. on the use of special clays as "sieves" for separating straight chain and branched chain hydrocarbons. At that time, the effective materials were found to be available in limited quantities, while synthetic adsorbents did not show enough capacity to look commercially promising.

Recently, U. S. patent 2,586,889 was issued to Standard Oil Development Co. It describes certain activated petroleum coke which may have promise in leading to a commercial process. Activated carbons made in the usual manner have some selectivity for separating straight chain from branched chain hydrocarbons. But their selectivity is too low. For instance, alpha (the selectivity coefficient) for wood charcoal and coconut charcoal falls in the range 1.3 to 2.0. Columbia G coconut shell charcoal has a capacity of 53 cc./g. and a selectivity of only 2.1 in the heptane-isooctane system.

The patent discloses the production of superior adsorbents from petroleum coke obtained from acid sludges, etc., by decomposing the sludge by contacting it in absence of air with a mass of hot coke, with continuous stirring at 400° F. to 750° F. for sufficient time to distill off the bulk of the volatile matter. The carbonized sludge then is transferred to a kiln where it is partially burned with air at 1000-1200° F. for 5-25 min. The bulk of the resulting hot coke is recycled to the decomposition zone to maintain the mass of coke there and to supply the necessary heat of carbonization, while the balance is removed as the desired product, which is cooled and granulated to the desired size. About 7 lbs. of hot coke are recycled for each lb. removed as product to be known as petroleum coke.

After removal, the coke is steamed, preferably in a fluidized bed at 1430° F. for 40 min. using 2.4 lb. steam per lb. of coke per hr. About 81.8 wt.-% of coke is thus obtained having a separation factor (alpha) of 7.6 and a capacity of about 29 cc. per 100 g. when used on n-heptane-isooctane at 70° F.

Data indicate that capacity of the coke increases from 7 cc. per 100 g. at 100% yield to about 75 cc. at 50% yield of coke. On the other hand, selectivity is critically dependent on the conditions and goes through a maximum (as shown in the illustration above), with the highest selectivity obtainable with yields of 82-85%. As is apparent from the chart, activation with air results in very low selectivity, while steam activation above 1600° F. also gives low selectivity.

This activated petroleum coke has been used for separating low octane number n-hexane from high octane hexanes, as can be seen from Table 1. In this case, the liquid hexane mixture was percolated through the coke at the rate of 6 lb. of coke per gal. of feed, and various filtrate fractions were removed and tested. Results on the adsorbate (the liquid adsorbed on the coke) indicate the high affinity of the adsorbent for straight chain hydrocarbons.

Such activated coke also was employed in separating olefinic feed stocks for the oxo-process, as well as for synthetic lubricants and rubbers. Table 2 shows results obtainable in separating hexene-1 from 2-ethyl-1-butene with a carbon of 28.6 cc./100 g. capacity (.034 gal./lb.) and 4.66 alpha at room temperature.

Table 1—Results Using Petroleum Coke for Separating Low Octane n-Hexane from High Octane Hexanes

	Composition, Vol. %				
Filtrate, Vol. % of Charge	N-Hexane	2 Me-Pentane	Cyclo-Hexane	Me-Cyclo-Pentane	Research Octane Number
0-6	3	28	32	29	81
6-27	11	35	28	27	76
27-76	20	32	22	27	71
Adsorbate (24%)	52	35	3	10	39
Original Feed	25	35	20	20	66

Table 2—Results Using Petroleum Coke for Separating Olefinic Feed Stocks

Carbon Treat 5.45 lbs./gal.	Feed	Super natant Liquid	ate
Concentration of Hexene-1	50.0	43.5	78.2
Concentration of 2-Ethyl-1-Butene	50.0	56.5	21.8

Patents

Two-Step Acid Treating Makes Better Catalysts

ACID treated bentonite clays used for cracking oils are generally treated with dilute hydrochloric or sulfuric acid to remove carbonates of magnesium, calcium, and iron, base exchange ions, lattice water, a portion of the lattice magnesium, a portion of lattice aluminum, and a minor portion, if any, of lattice silicon.

In its U. S. patent 2,579,576, Great Lakes Carbon Corp. brings out the fact that high catalytic activity and higher heat stability can be imparted to the clay if the acid treatment is performed in two steps. The procedure involves a preliminary conditioning step by treating bentonite clays at 10° to 40° C with an aqueous solution of a mineral acid whose concentration is between about 2% to 15% by weight, and thereafter separating the resulting solution from the insoluble clay material. The latter product then is activated by treating with additional portions of mineral acid having a concentration of 5% to 15% by weight, said treatment being conducted at between about 80° C. to the boiling point of the mixture.

Experiments are submitted showing that a catalyst made by the one-step treatment has an initial activity of 96-100%, and an activity, after heating at 700° C., of 53-83%. Using the two-step process, initial activity is reported as about 140, and activity after heating at 700° C. was 89%.

Catalyst Circulation Upped By Baffle Arrangement

CATALYST circulation in a Fluid type cracking unit can be improved by installing proper baffle arrangements in the zone where the spent catalyst line from the reactor joins the hot air duct leading to the regenerator.

The baffles are arranged to provide a cascading effect of downflowing catalyst through the zone. Preferably a center partition is provided, with dependent baffle plates arranged to cause deflection of the falling catalyst particles. A typical design utilizes at least five baffles on each side of the center partition, arranged in staggered fashion and at an angle greater than at right angles but less than 180°. The arrangement can perhaps best be described as appearing like a series of relatively flat gable roofs, one above the other and in step-back fashion.

Catalyst accumulations are therefore eliminated at this troublesome point and consequently also pressure drop and lowered capacity of the entire cracking unit. In an installation in a 25,000 to 30,000 b/d unit, catalyst circulation was approximately 44,000 tons/day. Prior to using the baffles, pressure drop across the duct to the regenerator was about 3 psig. After the baffles were put in, the pressure drop was lowered to about 0.3 psig.

U.S. 2,586,705, issued February 19, 1952, to Jewell S. Palmer, assignor, by mesne assignments, to Standard Oil Development Co., Elizabeth, N. J.

Patents Issued in March

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for March 4, 11, 18, and 25, Vol. 656, Nos. 1-4.

PROCESSES

Conversions

2,587,660-70 (Houdry Process Corp.): Processing liquid hydrocarbons with hot granular contact mass.

2,587,702 (Universal Oil Products Co.): Cracking heavy oils in presence of oxygen.

2,587,729 (Universal Oil Products Co.): Process for conversion of a mixture of hydrocarbonaceous solids and liquid hydrocarbons.

2,588,356 (Standard Oil Development Co.): Process for polymerization of propylene with liquid catalyst complex.

2,589,057 (Koppers Co., Inc.): Aromatic alkylation-dealkylation process.

2,589,124 (Standard Oil Development Co.): Method and apparatus for fluidizing fluidized solids.

2,589,273 (Gulf Research & Development Co.): Process for deoxygenating and isomerizing a Fischer-Tropsch stock.

2,589,523 (Pure Oil Co.): Blending of hydroforming feed stocks.

Refining

2,587,305 (Shell Development Co.): Separation of hydrogen halides from olefinically unsaturated compounds.

2,587,320 (E. Somerboro Sons, Inc.): Rotary kiln for the recovery of acid values.

2,587,440 (E. Somerboro Sons, Inc.): Recovery of acid values from petroleum refining sulfuric acid sludges.

2,587,443 (Koppers-Vacuum Oil Co.): Deasphalting mixtures of hydrocarbons with organic carbonate.

2,587,587 (Gulf Oil Corp.): Selective hydrodesulfurization process.

2,588,108 (Sinclair Refining Co.): Separation of propene and propane by extractive distillation with acetonitrile and acrylonitrile.

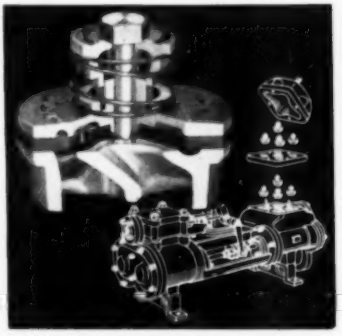
2,588,063 (Sinclair Refining Co.): Separation of propene and propane by extractive distillation with acetamol, propionamide and nitriles.

2,588,305 (Phillips Petroleum Co.): Process for distilling hydrocarbons.

2,588,321 (Sinclair-Telstad Corp.): Recovery of alkylation sludge acids.

2,588,348 (Houdry Process Corp.): Refining gasoline and petroleum oils with aqueous antimony trichloride.

HOW TO *Improve* PUMP PERFORMANCE *and Cut Costs*



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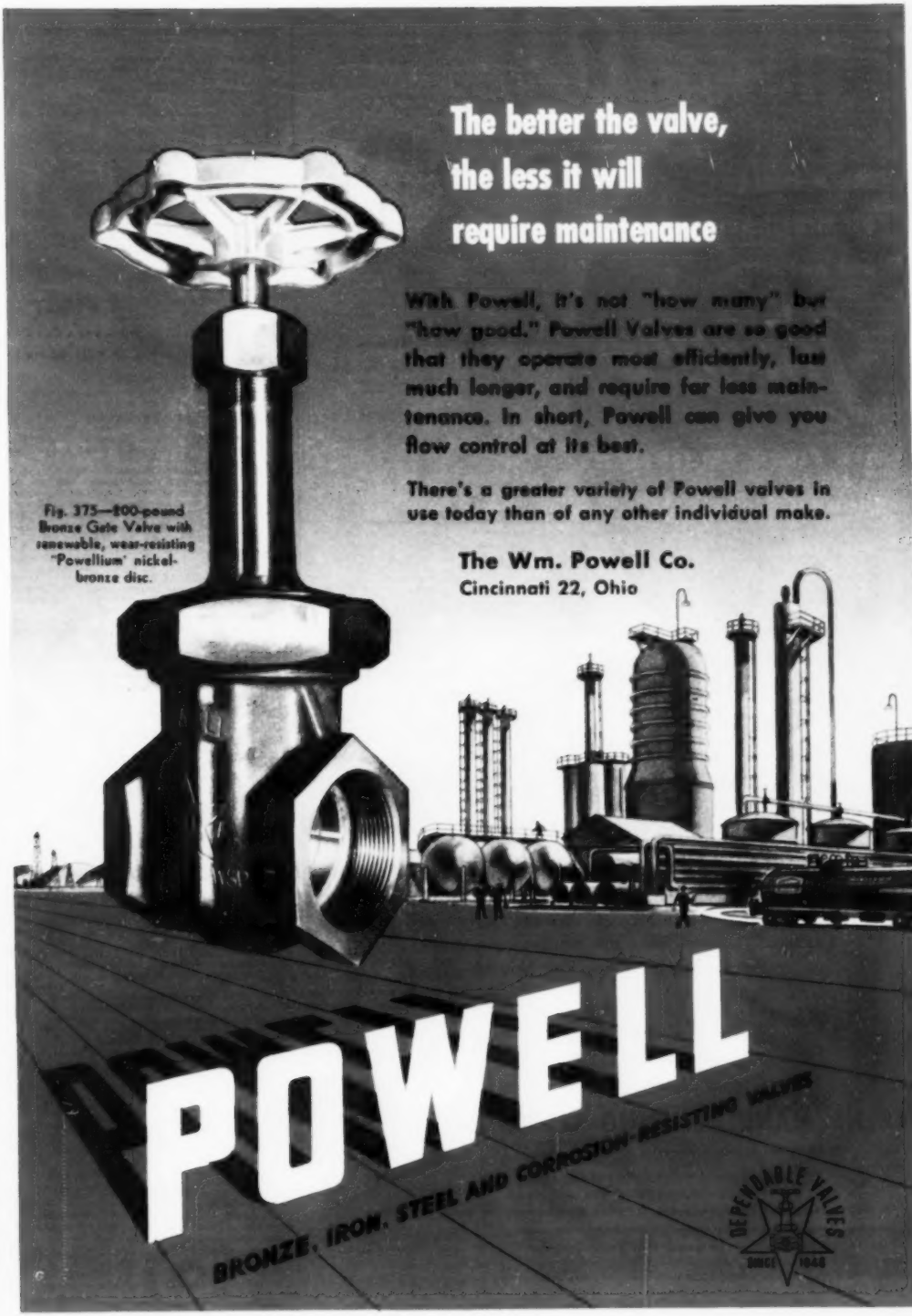
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Patents

2,588,506 (Shell Development Co.) Extractive fractionation process using urea or thiourea.

2,588,109 (Standard Oil Development Co.) Fluidized distillation of shale.

2,588,187 (Socony-Vacuum Oil Co.) Desulfurizing agent comprising caustic and thiophene tar distillate.

2,588,602 (Standard Oil Co., Ind.) Fractionation of organic compounds by urea adduct formation.

2,588,291 (Koppers Co., Inc.) Process of separating gases by diffusion.

2,588,300 (The Texas Co.) Process for separating normal aliphatic hydrocarbons from organic mixtures thereof, using 4, 4'-dinitrodiphenyl.

2,588,631 (Pure Oil Co.) Removing color bodies imparted to hydrocarbons in sweetening the same, using alkanolamine.

2,588,661 (Pure Oil Co.) Removal of mercaptans from hydrocarbons with caustic and sodium plumbite.

2,589,060 (Phillips Petroleum Co.) Recovery of olefin hydrocarbons with cuprous salt of o-phenetidine.

2,589,061 (Standard Oil Development Co.) Drying of solid adsorbents.

2,589,722 (Union Oil Co. of Cal.) Adsorption process.

2,589,830 (Phillips Petroleum Co.) HF refining of lubricating oil.

Hydrocarbon Synthesis

2,588,452 (Hydrocarbon Research, Inc.) Hydrocarbon synthesis using a spent ammonia synthesis catalyst.

2,588,511 (Phillips Petroleum Co.) Catalyst for the synthesis of hydrocarbons by reduction of carbon monoxide with hydrogen and process of utilizing same.

2,589,925 (Standard Oil Development Co.) Hydrocarbon synthesis.

Catalysts

2,588,402 (Houdry Process Corp.) Process and apparatus for producing hydrogel beads.

2,589,189 (The Atlantic Refining Co.) Silica-alumina-group VIII metal catalyst.

2,589,284 (M. W. Kellogg Co.) Catalyst stripping of fouled catalysts employed in hydrocarbon conversion processes.

PRODUCTS

Chemicals

2,587,576 (Standard Oil Co., Ind.) Higher alcohols from aldehydes.

2,587,577 (Universal Oil Products Co.) Production of arylindans.

2,587,588 (Diamond Alkali Co.) Method of preparing a drying oil by dehydrochlorination.

2,587,616 (Shell Development Co.) Alkylmercaptoalkyl phosphites.

2,587,666 (California Research Corp.) Oxidation of aromatic compounds containing oxygenated side chains.

2,587,689 (Phillips Petroleum Co.) Separation of acetylene from gaseous hydrocarbon mixtures with acetic anhydride.

2,587,753 (Stanolind Oil and Gas Co.) Method for purifying alcohols.

2,587,791 (Universal Oil Products Co.) Resinous copolymerization products from aromatic fulvenes.

2,587,858 (Shell Development Co.) Production of oxygenated compounds by carbonylation of olefin with CO and hydrogen.

2,587,900 (Shell Development Co.) Manufacture of detergents and wetting agents from olefins.

2,588,260 (Standard Oil Development Co.) Iron-manganese oxide oxidation carrier for the oxidation of hydrocarbons.

2,588,284 (Standard Oil Development Co.) Process for dehydrating isophorone fatty acid extract.

2,588,272 (Standard Oil Development Co.) Distillation of oxygenated organic compounds.

2,588,323 (Lummus Co.) Production of ethylene.

2,588,425 (Gulf Research & Development Co.) Preparation of tetra-isobutylene.

2,588,426 (Gulf Research & Development Co.) Preparation of triisobutylene.

2,588,446 (Standard Oil Development Co.) Purification of isopropanol.

2,588,625 (Pan American Refining Corp.) Production of drying oils by HF-hydrocarbon processing.

2,588,826 (Phillips Petroleum Co.) Process for the manufacture of improved drying oils by the condensation of unsaturated mineral oil polymers with aldehydes.

2,588,887 (Dow Chemical Co.) Pyrolytic production of chlorohydrocarbons.

2,588,890 (Shell Development Co.) Allyl alcohol-styrene copolymers.

Fuels

Lubricants

Specialties

EQUIPMENT

Processing, General

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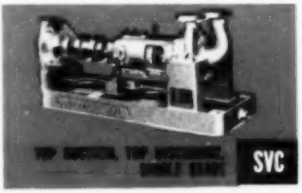

To Engineers responsible for operation and maintenance of plant equipment

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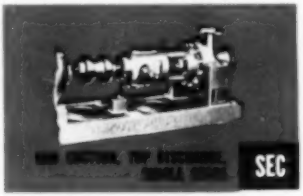

To the Owner of the plant

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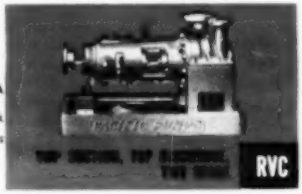


CP 5

Patents

exchanger for oxygen and nitrogen recirculation.

2,589,582 (Stratford Engrg. Corp.)—Apparatus and method for contacting gases and powdered solids.

2,589,145 (Elliott Co.)—Gas purifying apparatus and method.

2,589,148 (Union Oil Co. of Calif.)—Movable grid and flow control valve arrangement for maintaining level in a continuous selective adsorption unit.

2,589,865 (Griscom-Russell Co.)—Heat exchanger for a fluid and a mixture of gaseous and finely divided solid materials.

2,589,660 (United Carbon Co., Inc.)—Furnace for producing carbon black from hydrocarbons.

Instruments

2,588,214 (Standard Oil Development Co.)—Device for automatic control of subatmospheric pressures, particularly in the laboratory distillation of lubricating oils.

2,588,335 (United States of America, as represented by the Secretary of Agriculture)—Dew point apparatus.

2,588,621 and 2 (Minneapolis-Honeywell Regulator Co.)—Pneumatic control system and apparatus.

2,588,633 (Transducer Corp.)—Electric motor power supply control unit.

2,588,672 (Universal Oil Products Co.)—Photoelectric tube-actuated liquid level control.

2,588,678 (Minneapolis-Honeywell Regulator Co.)—Pneumatic measuring and controlling apparatus.

2,588,742 (Ferranti Ltd., Hollinwood, England)—Servo control system.

2,588,849 (Minneapolis-Honeywell Regulator Co.)—Pneumatic control apparatus.

2,588,879 (Shell Oil Co.)—Calibrated liquid level gage for sealed spherical pressure vessels.

2,588,882 (Shell Development Co.)—Temperature compensator for capacitors.

2,588,988 (Mason-Neilan Regulator Co.)—Follow type servo-motor for a valve positioner.

2,589,041 (The Foxboro Co.)—Resistance thermometer.

2,589,324 (Barton Jones)—Temperature compensator for measuring differential pressures.

2,589,396 (Phillips Petroleum Co.)—Pressure regulator in which freezing is inhibited.

2,589,650 (Julian A. Campbell)—Liquid level control.

Valves & Fittings

2,587,500 (M & J Engineering Co.)—Motor valve and positioner.

2,587,933 (Alexander S. Volpin)—Shear relief valve.

2,587,934 (Alexander S. Volpin)—Valve indicator.

2,588,157 (Phillips Petroleum Co.)—Relief valve.

2,588,312 (Standard Oil Development Co.)—Foam distributor nozzle.

2,588,313 (Phillips Petroleum Co.)—Wedge closure fitting for relatively high temperatures and pressures.

2,588,576 (Shell Oil Co.)—Safe gaging and sampling hatch for volatile liquid storage tanks.

2,589,144 (Standard Oil Development Co.)—Pressure relief valve.

2,589,176 (Thomas Wheatley)—Check valve assembly.

2,589,581 (Edward Sikolski)—Vertical horizontal ball check valve.

2,589,712 (Langenkamp-Wheeler Brass Works Inc.)—Flow line sampler.

2,589,715 (Frank H. Sasse)—Variable throat liquid flow control valve.

2,590,256 (Alfred E. Hofmann)—Excess flow check valve.

Miscellaneous

2,588,214 (Standard Oil Development Co.)—Apparatus for limiting the degree of subatmospheric pressures.

2,588,430 (Odin Corp.)—Rotary, high pressure blade pump.

2,589,093 (Clarence D. Lindsey)—Vapor control system for storage tanks.

2,589,219 (Pure Oil Co.)—Method of studying earth formations employing acetylene as a tracer gas.

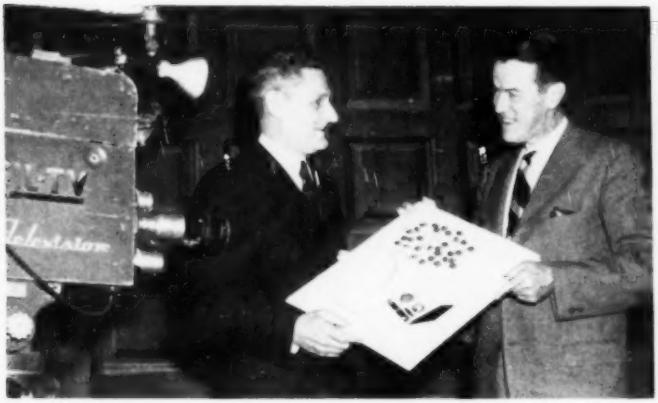
2,589,631 (Crane Packing Co.)—Drive for washer of mechanical rotary seals.

2,589,706 (Wilbur F. Bernstein)—Magnetic oil seal construction.

2,590,036 (Union Carbide & Carbon Corp.)—Shaft seal for rotary pump handling highly volatile liquefied gas.

2,590,759 (Bump Pump Co.)—Rotary shaft seal.

PERSONALS



TV Casts Atom's Role in Petroleum Research

Successful application of atomic energy to petroleum research is outlined for a television audience by **Dr. J. C. Geniesse** (left), of Atlantic Refining Co.'s Research and Development department. Here he is shown using a chart to demonstrate one of his points to **John McCullough**, moderator of the TV show. The program was televised in Philadelphia.

API Cites Cal Standard's Safety Record

The American Petroleum Institute has presented 11 Accident Prevention Certificate Awards to Standard Oil Co. of Calif. in recognition of 10,500,000 man-hours worked by employes without a disabling injury. Nine million-hour certificates were awarded to units of the company's Richmond refinery. **T. S. Petersen** (extreme right), president of California Standard, acted in behalf of the API in presenting the awards. Attending the presentation were (left to right): **R. E. Donovan**, manager of California Standard's Safety Div. of Personnel Dept.; **W. W. Davison**, **Gage Lund**, and **Jules Toussaint**, vice presidents. Mr. Davison and Mr. Lund accepted the awards, as the records were achieved under their jurisdiction.

* * *

The Fourth Annual Honor Scroll Award of the New York Chapter of the American Institute of Chemists will be presented this year to **Dr. Foster Dee Snell**, president of Foster D. Snell, Inc., consulting chemists. The award, given annually for outstanding contributions to the profession of chemistry, will be presented to Dr. Snell at a dinner meeting in the Hotel Commodore, New York, on May 22. **Dr. Gustav Egloff**, director of research of the Universal Oil Products Co., Chicago, will speak about "Foster D., As I Know Him."

* * *

Harry T. Klein, The Texas Co., has been elected to the newly created post of chairman of the executive committee. In taking up his new position, Mr. Klein is succeeded as president of The Texas Co. by **J. Sayles Leach**, formerly one of the company's two executive vice presidents.

* * *

Dr. George E. Holbrook, assistant director of the development department of E. I. du Pont de Nemours & Co. Inc., Wilmington, Del., has been appointed deputy director of National Production Authority's Chemical Division.

* * *

Dr. Robert C. Swain, American Cyanamid Co. vice president, has been named a director of the Stanford Research Institute, San Francisco.

* * *

T. L. Apjohn, Socony-Vacuum Oil Co., Inc., has been appointed manager of the wholesale division of the lubricating department.

Mr. Apjohn was formerly supervisor of the products division of the company's research and development department, Paulsboro, N. J. During 1951 he served with the Petroleum Administration for Defense as assistant director of refining and director of the aviation fuels program.

In his new position, Mr. Apjohn succeeds **H. L. Moore** who has been appointed assistant manager of the national accounts department.

* * *

J. M. Pritchard, former president of McColl-Frontenac Oil Co. Ltd., has been elected chairman of the board to succeed **A. A. Magee**, who assumes the new position of chairman of the executive committee. **A. G. Farquharson** has been elected vice president in charge of refining.

* * *

Reginald J. S. Pigott, director of the engineering division of Gulf Research and Development Corp., was the recipient last month of the Egleston Medal for 1952. The award is presented annually for distinguished engineering achievement.

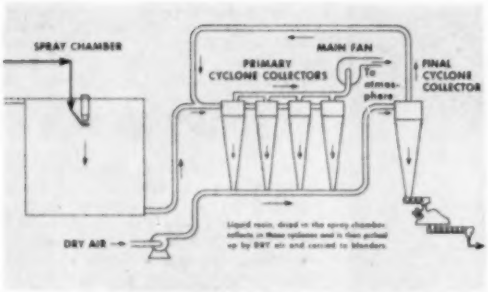
* * *

David W. Harris, president and a director of Universal Oil Products Co., Chicago, will deliver the address at the sixty-ninth commencement exercises of Georgia Institute of Technology on June 9th at Atlanta, Ga.

* * *

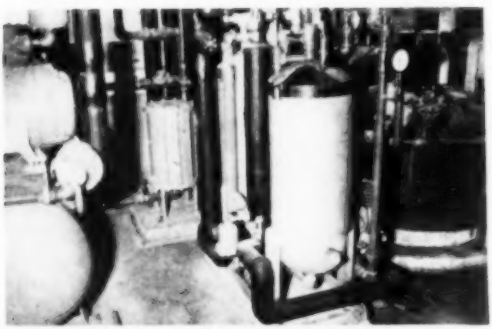
Jack D. Fuller, who joined Ethyl Corp. in 1941, has been named to the newly-created position of manager of fuel technology. His headquarters

LECTRODRYERS are production tools at these American *Cyanamid* Plants



DRY air picks up powdered resin to keep it DRY at American Cyanamid's Wallingford, Conn. plant

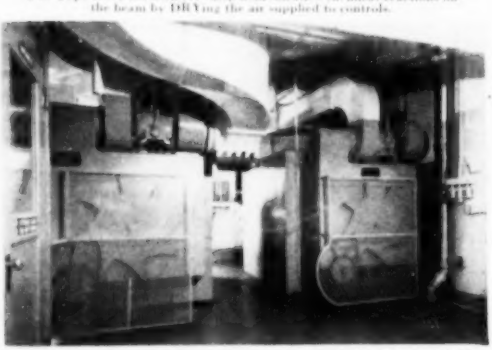
Get molding powders DRY and keep them that way: that's the function of this portion of the production line in this ultramodern plant. There's no moisture in the air that picks up molding powders as they come from the cyclones—no moisture to impair the quality American Cyanamid has compounded into these products.



Two Type BY-1 Lectrodryers help hold sensitive chemical reactions on the beam by DRYing the air supplied to controls.

On instrument air at Calco Chemical Division, Willow Island, W. Va.

No moisture gets into air lines here to condense, form ice, rust or sludge and cause trouble. Two Lectrodryers* designed especially for instrument air work, catch the vaporous moisture which aftercoolers, filters and separators let by. Calco Chemical Division's products are consistently higher in quality, therefore.



Aureomycin and penicillin are packed in a sterile area where the air is held at 8% relative humidity by these Lectrodryers.

Holding humidities constant at Lederle Laboratories Div., Pearl River, New York

Control the quality of air surrounding processes, just as you control materials going into products; this is a rule for quality production at Lederle Laboratories Division, as at the other divisions of American Cyanamid Company. Besides sterilizing the air here, Lectrodryers hold it at a constant temperature and humidity.

You probably have plenty of places where Lectrodryers will help you boost quality and speed production. For help in finding out, write Pittsburgh Lectrodryer Corporation, 332 32nd Street, Pittsburgh 30, Pennsylvania.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U. S. PAT. OFF.

(To obtain more data on advertised products see page 6961)

Personals

will be at the company's research laboratories in Detroit. As fuel technologist in the Central Region for the last four years, he has been assisting refiners in the solution of blending problems.

* * *

Standard Oil Co. (Ind.) has made three personnel changes at its Whiting, Ind., research laboratories. **L. W. Russum** has been promoted to section leader heading the process economics section of the process division. **W. E. Kennel** has been advanced to group leader of the process design and economics group of the chemical products division to succeed Dr. Russum. **E. W. Kane** has been promoted to group leader in the process economics section of the process division.

Dr. Russum joined Indiana Standard in 1947 as a chemical engineer and became group leader in 1948. He is a graduate of the University of Arkansas and received his doctor's degree from Massachusetts Institute of Technology.

Dr. Kennel became associated with the company in 1948 as a chemical engineer. He did his undergraduate work at the University of Illinois and received a Ph. D. degree from M. I. T.

Mr. Kane joined the company in 1947 as a chemical engineer. After graduating from Case Institute, he received a master's degree from M. I. T.

* * *

Henry Eichner has been named manager of the distilling department of Shell Oil's Martinez, Calif. refinery, succeeding **H. E. Crane,** who has retired.

Mr. Eichner, a University of California graduate, joined Shell in 1932 as a chemist at Martinez. After serving in several technological positions, he was appointed manager of the Martinez asphalt department in 1940.

* * *

Abbott K. Hamilton, a vice president of Commercial Solvents Corp., has been placed in charge of the Product Divisions. He succeeds **H. J. Henry** who recently resigned.

Mr. Hamilton has been with Commercial Solvents since 1946 when the Corporation purchased Pennsylvania Alcohol and Chemical Corp. of which he was vice president.

* * *

A. P. Frame has returned to his post with the Cities Service organization after 18 months of service on loan to the Petroleum Administration for Defense. Upon his return he was elected first vice president of Cities Service Petroleum, Inc. Formerly known as Petroleum Advisers, Inc., this firm serves as the coordinating company for the petroleum operations of the Cities Service organization.

In addition to his new office, Mr. Frame has resumed his former po-

SAFETY FEATURE ADDED TO

Ohio's Type 1000

RETURN BEND

BAR-TYPE PLUG PULLER PROTECTS *the* MAINTENANCE MAN

- One-man operation
- No loose pieces
- Holds plug in place after seal is broken
- Cannot damage return-bend seat or plug
- Full leverage on closest centers
- Pullers available for all sizes (separate puller required for each size)

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO—Plants at Lima and Springfield, Ohio

District offices in:

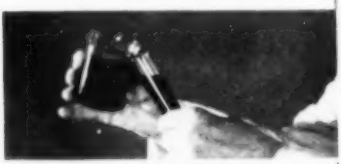
Chicago, Cincinnati, Cleveland, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis, Tulsa

(To obtain more data on advertised products see page 696)

Tenamene

the most effective additives known . . . keep gasoline cleaner . . . longer . . . at low cost

WHAT IS GUM? Gum is a non-volatile material resembling varnish or lacquer. Soluble in gasoline, gum separates only when gasoline evaporates, unless highly concentrated. Sometimes gum settles as a heavy, dark brown oil. The enemy of engine efficiency, gum coats carburetors, plugs jets and screens, and causes valves to stick.



WHAT INHIBITORS DO. Commercial gasoline inhibitors retard oxidative deterioration, the first step in gum formation. To prevent storage loss, inhibitors should be soluble in gasoline but not in water. They should not color gasoline and should resist darkening.

THE TENAMENES — EASTMAN INHIBITORS. For years Eastman has made the most effective gum inhibitors known—Tenamene 1 and Tenamene 2. Formerly these were sold through another company under another name. Now Eastman makes them available directly and from convenient stocks. Choice between the two gum inhibitors depends on a number of factors, such as the crude, the treatment and possible caustic carryover. Tenamene 2 should be used where traces of caustic are present. Where caustic is not present, choice must be based on such tests as ASTM Gum, Oxygen Bomb or Copper-dish Gum. Since Tenamene 2 is more concentrated and non-inflammable, its slightly higher cost is frequently more than offset by lower shipping costs.

FOR MOTOR FUELS. Tenamene 1 is a mobile, tan liquid composed of 48% N-n-butyl p-aminophenol in isopropanol. 5 to 52 lbs. per 1000 bbls. inhibit gum in most motor fuels, protect dyes from fading, and retard tetraethyl lead decomposition.

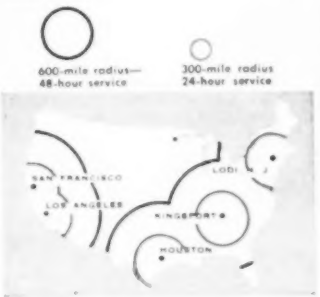
FOR MOTOR FUELS AND ALL AVIATION GASOLINES. Tenamene 2 is a mobile tan-to-red liquid comprising N,N'-di-sec-butyl p-phenylenediamine. For motor fuels generally, 2.6 to 26 lbs. per 1000 bbls. are used. Tenamene 2 has been thoroughly tested in aviation gasolines and approved for military purposes. It is highly resistant to extraction by water and caustic solutions. In hot, humid climates Tenamene 2 greatly retards deterioration of aviation gasoline that results in lead deposits. The maximum concentration allowable in aviation gasolines (8.4 lbs. per 1000 bbls.) should be added.

FOR COPPER CONTAMINATION. Tenamene 60, third member of the Tenamenes, is a mobile, red liquid composed of 80% disalicylal propylene di-imine in toluene. Traces of copper are often found in gasoline—from treating processes or from copper equipment employed during production, storage or use. Tenamene 60 overcomes the catalytic effect of copper on the oxidation stability of gasoline.

TESTS PROVE TENAMENE EFFECTIVE. Various tests with all types of gasoline proved the effectiveness of the Tenamenes. Uninhibited gasoline deteriorated rapidly in storage, forming considerable gum. Tenamene stabilized gasoline formed little gum in prolonged storage. Tennessee Eastman will be glad to make these analyses on any refiner's gasoline.

HOW TO USE TENAMENE. In general, unrefined cracked gasoline should be treated with Tenamene promptly after condensation. Refined gasoline should be treated as it is pumped to storage. If delay is necessary, add small amounts initially, the balance later. Tenamenes can be added in concentration, but are better added as dilute stock solutions since small quantities are generally involved. Common procedures are the proportioning pump, eductor or gas-pressure method. Tenamene 1 and 2 should be protected from air to prevent discoloration. Tenamene 60, however, does not need inert atmosphere for application.

WHERE CAN YOU GET TENAMENE? Eastman can give top service on your requirements of these excellent additives. Stocks of Tenamene are carried at five convenient locations. A glance at the map below shows delivery schedules. Write to one of our sales representatives* or to Kingsport, Tennessee for prices, specifications, and other information.



Tenamene EASTMAN GASOLINE ADDITIVES

TENNESSEE EASTMAN COMPANY, *Division of Eastman Kodak Company, Kingsport, Tennessee*

***SALES REPRESENTATIVES:** New York—10 E. 40 St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; Houston—412 Main St. **WEST COAST:** Wilson Meyer Co., San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Seattle—821 Second Ave.

(To obtain more data on advertised products see page 696)

sitions as president of Cities Service Research and Development Co., vice president of the Cities Service Refining Corp. and Cit-Con Oil Corp.

* * *

Recent additions to the staff of the research and development division of Commercial Solvents Corp. at Terre Haute, Ind., include **John A. Frump** and **Gerald R. Wagner**, both research chemists. Mr. Frump was previously employed as an analytical chemist by Auto-Lite Corp. of Vincennes, Ind. Mr. Wagner received his M. S. degree in chemistry this year from the University of Arkansas.

* * *

A new industrial safety record was established by Shell Development Co., Emeryville, Calif., at the end of March, when the two-millionth consecutive man hour was passed without a disabling injury.

* * *

Monsanto Chemical Co. has awarded a fellowship to **Jim Smither Berry**, of Austin, Tex., for the '52-'53 academic year to further his graduate studies at the University of Texas. His Ph. D. topics are: 1) Structural Studies on von Braun's $C_7H_{12}O$ Ketone, and 2) Synthesis of Certain Bicyclic Acids.

The University of Texas is one of 13 universities cooperating in Monsanto's fellowship program.

* * *

W. V. Cropper has been promoted to assistant chief chemist of Standard Oil Co. (Ind.) research laboratories at Whiting, Ind. Succeeding him as group leader at the company's Casper, Wyo., laboratory, is **H. M. Schauer**, formerly a chemical engineer at Whiting.

* * *

A. Wesley Hoge has been placed in charge of process design and **David B. Ardern** in charge of technical service for the Houdry Process Corp. Joining the company in 1943, Mr. Hoge has continuously served in the technical service division for the past nine years. He attended Wittenberg College and is a graduate of Ohio State University, from which he received a B. S. degree in metallurgy.

Mr. Ardern joined Houdry in 1942 and has been primarily engaged in process design, concentrating on the commercial design of Houdriflow moving-bed catalytic cracking units, and the more recent Houdriforming units for catalytic reforming. He received his B. S. and M. S. in chemical engineering from the University of Louisville.

* * *

Two new directors of Hercules Powder Co., Wilmington, Del., were elected at the company's annual meeting on March 18th. They are **Elmer F. Hinner**, general manager of the Virginia Cellulose Dept., and **Paul Mayfield**, general manager of the Naval Stores Dept.

Mr. Hinner has been associated with Hercules since 1927. From 1940 to 1950 he served as special assistant and later as assistant general manager of the chemical cotton manufacturing department. He was promoted to general manager of the department in 1950. Mr. Hinner is a graduate of Pennsylvania State College.

Mr. Mayfield was named general manager of the company's terpene and rosin chemicals operations last December. He had been assistant general manager of that department since 1943. He has been associated with Hercules for 27 years. Upon graduating from Indiana University in 1925, he engaged in sales and technical service work, developing markets for both cellulose and naval stores products.

* * *

A. W. Andrews has been named operating superintendent at the East St. Louis refinery of Socony-Vacuum Oil Co. Inc. Filling the vacancy created by Mr. Andrews' appointment is **R. S. F. Grieve**, former process engineer.

* * *

Walter R. Bateman has been appointed acting manager of Reconstruction Finance Corp.'s synthetic rubber plant at Fort Neches, Tex. The plant is operated by the B. F. Goodrich Chemical Co. Mr. Bateman replaces **J. Ernest Miller** who was recently appointed to serve as assistant to **Leland Spencer**, chief of the RFC synthetic rubber division. Mr. Miller has been with the Goodrich Co. since graduating from Wooster College in 1933.

Mr. Bateman graduated in 1935 from the University of North Carolina with a degree in chemical engineering. He joined Goodrich Chemical in 1942 as a chemical engineer and was made production manager at Port Neches in 1945.

PROCESS ENGINEERS

California engineering company has responsible permanent staff positions open to graduate chemical engineers with broad experience on design of condensers, stills, absorption towers and related petroleum refinery and chemical plant equipment.

Write giving full details, references, salary requirements. Your reply will be held confidential.

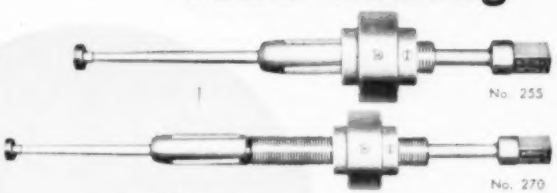
Our organization knows of this ad.

BOX 42

IDEAL

Precision-Built for faster, smoother

Tube Rolling



For Rolling Tubes in Condensers, Coolers and other Heat-transfer Units you'll get Better results with IDEAL Tube Expanders No. 255 and 270. Ball bearing, adjustable thrust collar reduces friction to a minimum. Sizes from ¼" thru 1½".

Wiedeke modern manufacturing methods assure prompt service and quick delivery.

No. 255 for average sheets
No. 270 for thick or multiple-tube sheets

See Your Dealer or Write Us Today!

THE GUSTAV **WIEDEKE** COMPANY
DAYTON 1, OHIO

(To obtain more data on advertised products see page 696)

How porous *do you want your* catalyst supports?

Norton catalyst supports come in two types:

1. If your process calls for coated catalyst supports, you get what you want from Norton medium-porosity spheres. They have a porosity of 30-33%, with a rough, open surface structure. This gives you maximum adherence of catalyst to surface.

2. If you need supports for impregnation, Norton high-porosity spheres are your choice. Their porosity is 42-47% with large, connected, internal pores uniformly dispersed throughout the support. This gives you maximum deposition of catalyst.

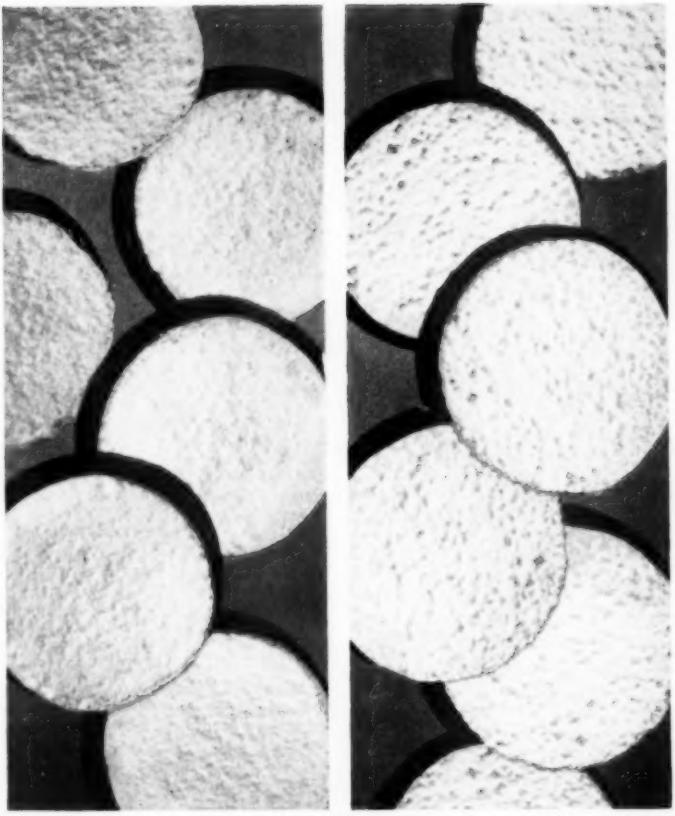
You also have a choice of sizes and shapes. Norton spheres are available in diameters of 3/16" to 1". Other Norton catalyst supports, in ring and pellet form, available in diameters of 1/8" to 2".

A choice of materials, too. Norton catalyst supports can be made from a variety of refractory materials, offering many different combinations of properties.

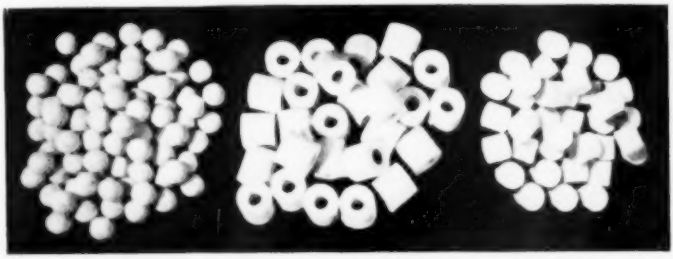
Test them in action

You can easily prove, in your own plant, what Norton catalyst supports can do towards improving your production. Want to see samples? Contact your Norton representative or write direct to Norton Company, 261 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ont.

NORTON HEAT EXCHANGE PEBBLES
also offer you worthwhile advantages, especially where alternating oxidizing and reducing atmospheres are met. They're made of ALUNDUM* electrically fused alumina (alumina content 95% to 99%). Nothing like them for static or moving heat exchange beds.



Greatly enlarged views of the two types of Norton catalyst support spheres. *Left: Norton Medium-Porosity Spheres* have pores close to surface. *Right: Norton High-Porosity Spheres* have connected pores throughout. You can also get Norton Low-Porosity Spheres if required.



Norton catalyst supports are made in sphere, ring, and pellet form.

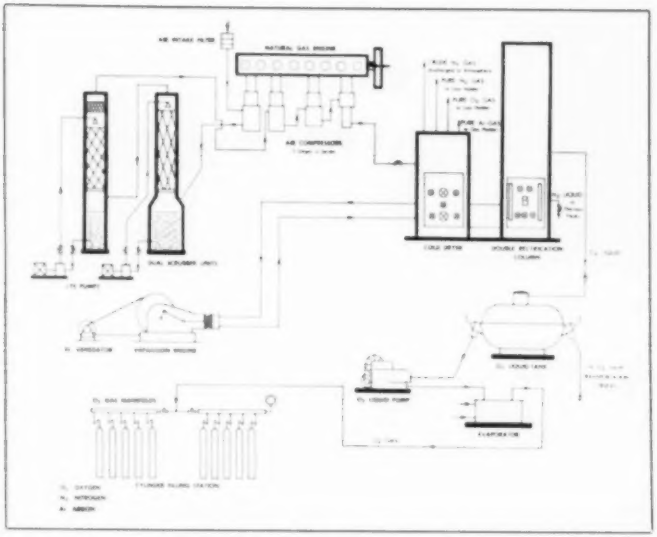
*Trade Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON

Special REFRACTORIES

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS



Houston Oxygen Co.'s Plant On Stream

Anticipating the rapidly expanding needs of the Southwest's industrial development, the Houston Oxygen Co. has begun operations in its new million-dollar plant for the production of pure liquid oxygen and liquid nitrogen, in addition to pure oxygen, nitrogen and argon gases. From the plant, a central system pipeline supplies many industrial users with oxygen gas. It is the first multiple-customer pipeline in the world. The simplified flow sheet (above) illustrates process principles on how these products are produced at the plant.

Named Manager of New Division

Henry E. Craven, Jr., has been appointed manager of the newly organized Lake Charles Division of the Davison Chemical Corp., which is presently building a large plant on the Calcasieu River, south of Lake Charles, La. There they will produce petroleum cracking catalyst and other chemicals.

Mr. Craven

Mr. Craven is a graduate in ceramic engineering of North Carolina State College. He came to Davison in 1951 from Pemco Corp. of Baltimore, where he was plant manager from 1946 to 1951.

Sells Interest in Attapulgus Clay

Standard Oil Co. (N. J.) has sold its 50% interest in Attapulgus Clay Co. to F. Eberstadt & Co., Inc., and Lazard Freres Co., New York, for an undisclosed sum. Attapulgus and Filtrol Co. of California, a publicly owned holding company, are joint owners of Filtrol Corp. Atlantic Refining Co. holds the other 50% interest in Attapulgus, which produces Fuller's earth products.

Ferdinand Eberstadt and David E. Lilienthal joined both the Filtrol Corp. and Attapulgus boards of directors, replacing the Jersey Standard representatives.

Blaw-Knox Has New Pittsburgh

The Chemical Plants Division of Blaw-Knox Co. has moved into its new headquarters building located on Duquesne Way in downtown Pittsburgh. The three-story structure is air-conditioned and well lighted and has a frame of precast, reinforced concrete. It meets the division's primary needs in the Pittsburgh area for both administrative and engineering quarters. Located on a plot of about 1½ acres, it occupies about half of the land area, the remainder being used for parking space and a small service building.

Offices for several of the technical departments are on the first floor, while executive offices and a special conference room are on the second floor. Offices for the construction department, project engineers, research group, accounting department, and several process departments are also on this floor. The third floor contains another large engineering department, a materials laboratory, and additional conference rooms and offices.

Joins Heyl & Patterson

John L. Michaelis, formerly chief engineer of Columbia Southern Chemical Corp.'s New Martinsville plant, has joined Heyl & Patterson, Inc. of Pittsburgh, as contracting engineer. His duties will be the sales and service of the American line of Reineveld centrifuges and separators.

Mr. Michaelis

Mr. Michaelis graduated from Ohio State University in 1936 as an electrical engineer. For the past 15 years he has been engaged in mechanical and electrical phases of chemical plant maintenance and construction work. He recently returned from a two-month trip to Western Europe where he studied actual installations and applications of the Reineveld centrifuges.

Creates Four Divisions

In beginning its fifty-first year of business, The Vulcan Copper & Supply Co. of Cincinnati has organized the company's operations into four separate divisions, each one functioning independently of the other.

Mr. Gould

The Vulcan Engineering Division carries on its established services to the chemical and process industries by offering expanded facilities for the technical and economic surveys, process development, process and plant design, equipment design and procurement, over-all erection and construction supervision, plant start-up and initial operation. Merle L. Gould, associated for the past nine years with the Shell Development Co., Emeryville, Calif., has been appointed chief development engineer. He will head the Development Department. Mr. Gould is a

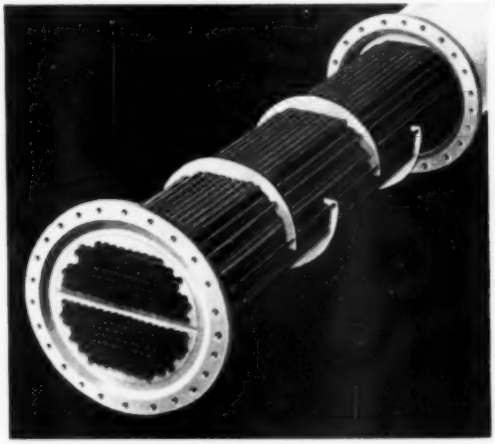
How to Cut Down Shutdowns

Anyone engaged in the refining industry, which works continuously around the clock, knows that shutdowns are expensive.

The one thing that will help reduce these shutdowns is more care exercised in the selection of materials that go to make up the equipment. Every part must function with dependability. And what part demands more dependability than the condenser tubes?

The condenser tubes that are recognized everywhere for their unquestioned dependability are Wolverine seamless, nonferrous tubes—the tubes that are quality controlled from ore to finished product.

These condenser tubes are available in any copper alloy that you may require to meet your particular conditions. Our engineers are always ready to consult with you on the most suitable alloy to use in your particular application.



WOLVERINE TUBE DIVISION

Calumet & Hecla Consolidated Copper Company

INCORPORATED

Manufacturers of seamless, nonferrous tubing

1425 CENTRAL AVENUE • DETROIT 9, MICHIGAN

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA

Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York City 16, N. Y.

graduate of the University of Nebraska.

The Manufacturing Division continues its fabrication of distillation, evaporation and extraction equipment. The Construction Division is now performing contracts for the complete erection of chemical plants, including structures and utilities, and the installation of processing equipment. The Industrial Supply Division operates warehousing and distribution of all types of tools, factory supplies, copper, brass, and alloy products, throughout the southern Ohio and northern Kentucky areas.

Other recent appointments include George F. Kline as project engineer, and F. Corson Cunningham as process engineer. Both are employed in the process engineering department.

Named VP of Sales

Willard M. Broxham has been named vice president in charge of sales for Graver Tank & Mfg. Co. Inc., East Chicago, Ind., fabricators in steels and alloys. Mr. Broxham has spent more than 30 years with Graver, almost entirely in the sales department. His first years with the company were devoted to engineering, production planning and time studies, but since 1929 he has been associated solely with the sales department. In 1946 he was made sales manager for the Fabricated Plate Division, and in 1950 was made manager of sales for all divisions.

Mr. Broxham

ASLE Chooses Officers

Four petroleum industry men were among officers and directors elected for the coming year by the American Society of Lubrication Engineers at their 7th annual meeting in Cleveland, April 7-9.

W. L. Fowler, Pure Oil Co. research and development laboratories, was named secretary-treasurer; A. S. Horwitze, E. F. Houghton & Co., San Francisco, was made western regional vice-president; J. W. Hopkinson, Penn Petroleum Corp., Detroit, midwest vice-pres.; and Arthur O. Willey, Lubrizol Corp., Cleveland, was elected a director.

Other officers are as follows: M. E. Merchant, Cincinnati Milling Machine Co., president; W. E. Campbell, Bell Telephone Laboratories, vice-president at large; H. E. Mahncke, Westinghouse Electric Corp., eastern regional vice-pres.; T. A. Marshall, Steel Co. of Canada Ltd., Hamilton, vice-pres.; and Ralph Wilson, Wilson Mfg. Co., Detroit, treasurer.

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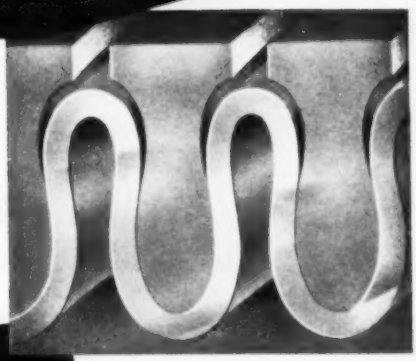

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Badger Manufacturing Company developed its *Directed-Flexing, Self-Equalizing* expansion joints with lasting protection to costly equipment in mind. The all-curve pattern of the corrugated member eliminates sharp bends and structure weakening stresses which assure long maintenance-free life.

In combination with the correspondingly shaped Badger Self-Equalizing ring, progressively controlled movement of *each* corrugation insures a more flexible, longer lasting joint. Buy Badger Joints and you get flexibility, Directed-Flexing Self-Equalizing and these features:

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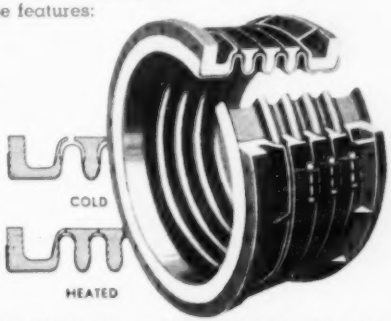
- Wide range of traverse — pressure — temperature Fabricated from deoxidized copper, stainless steel and special alloys to meet various operating conditions.



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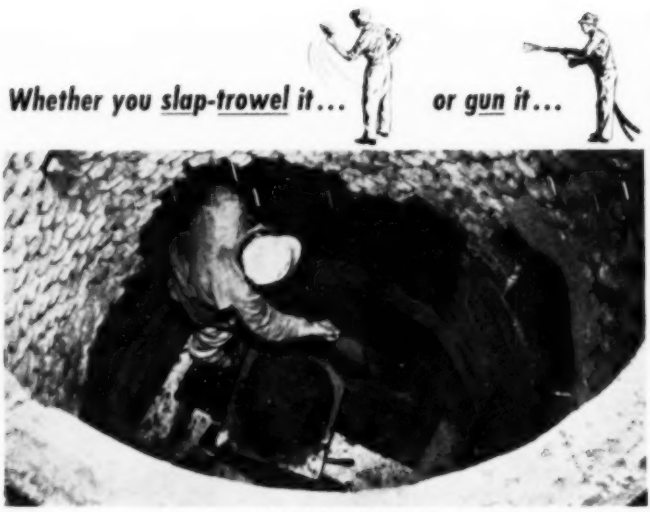
(To obtain more data on advertised products see page 696)



Slap-troweling Blazecrete on a furnace lining under repair.

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REFRACTORY LININGS

News of Suppliers

Ontario, Canadian vice-pres.; C. E. Schmitz, Crane Packing Co., chairman of president's council.

Norton Joins Hollingshead

Mr. Norton

Wilbur H. Norton, vice president of General Motors has been named president and a member of the board of the R. H. Hollingshead Corp. of Camden, N. J., manufacturers of maintenance chemicals. Mr. Norton is to have charge of plans and policies in expanding company's activities. He will direct research in such fields as hydraulic fluids, lubricants, corrosion preventive compounds, vinyl plastics and atomic energy.

Establishes Washington Office

Charles F. McKenna, Jr., has established an office at 2300 Connecticut Ave., Washington, D. C., where he will represent industrial groups operating in the chemical process industries. He is a veteran of 30 years experience in the organic chemical and process industries.

For the past year he handled the procurement of raw materials for all divisions of the General Aniline & Film Corp. He was employed as the company's Washington representative. Prior to joining General Aniline in 1945, Mr. McKenna was with Commercial Solvents Corp. for 17 years in the market development and sales departments. He holds a B.S. in chemistry and has had two years of chemical engineering at Polytechnic Institute of Brooklyn.

Fischer & Porter Relocated

Fischer & Porter Co. now is occupying new quarters at 6626 Maple Ave. in Dallas with R. W. "Bob" Fritzsche in charge. The new facilities will serve as headquarters for its Southwestern operations, which roughly embraces the region between the Continental Divide and the Mississippi River south of Minnesota and South Dakota. Offices are also located in Houston, New Orleans, Tulsa, Memphis, St. Louis, Kansas City, Denver and also Midland, Texas.

The new Dallas building has an area of 1000 sq. ft. located on an 8000 sq. ft. tract to permit future expansion, divided into 600 sq. ft. of warehouse and 400 sq. ft. of offices. Facilities are provided to stock and ship preassembled instruments and to make instrument repairs. The construction features movable walls to enlarge either office or warehouse space as necessary.

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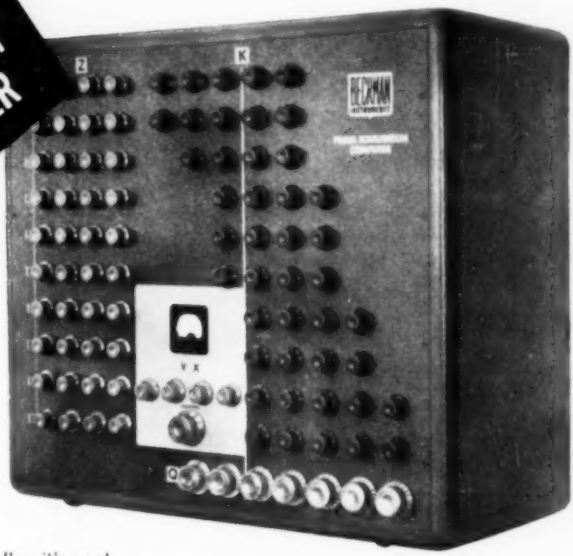

Vapor-liquid relationships are an important factor in the design and operation of many petroleum and petro-chemical processes. But the laborious, trial-and-error methods now used for solving such relationships are time-consuming, tedious and greatly limit the productive capacity of technically-trained personnel.

Now such equations can be solved quickly, accurately, economically with the new electronic Beckman Phase Equilibrium Computer.

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With this new Beckman advancement, a non-technical operator can solve complex flash equilibrium equations in three to four minutes as compared with as much as 1½ hours required by highly trained personnel using present trial-and-error calculating procedures.

The data—consisting of analyses of the feed, together with equilibrium constants for the given temperatures and pressures—is merely set into the machine by means of numbered decade dials.

A few dials are adjusted to balance the network, as indicated on a null-indicating meter, and the ratio of total liquid to total vapor is solved. Similarly, subsequent balances solve the liquid fraction of each constituent and the vapor feed ratio.

Accuracy for each constituent is within 0.05% of the total liquid, and as many as 10 feed constituents can be set into the machine at one time!

How it's used . . .

The Beckman Phase Equilibrium Computer is an invaluable aid in a wide range of applications . . .

- *In designing fractionators, absorbers and other refinery equipment, the interaction of gas and liquid phases with temperature and pressure variations throughout the columns can be quickly and accurately evaluated.*
- *Valuable time is saved in designing surface separator systems for optimum operating temperatures and pressures, assuring maximum recovery of the desirable constituents.*
- *In field production operations, the nature and amount of gas developed in the reservoir as pressures decline can be quickly and accurately determined . . . better gas-oil ratios can be maintained and optimum recovery obtained.*

The time saved in getting just *one* refinery job on stream can more than repay the cost of a Beckman Phase Equilibrium Computer . . . and the instrument continues saving time, cutting costs, boosting manpower efficiency year after year on a wide range of vapor-liquid computations. It will pay you to get the full story on this new Beckman advancement!

Send for Bulletin 2"—288, which describes this instrument!

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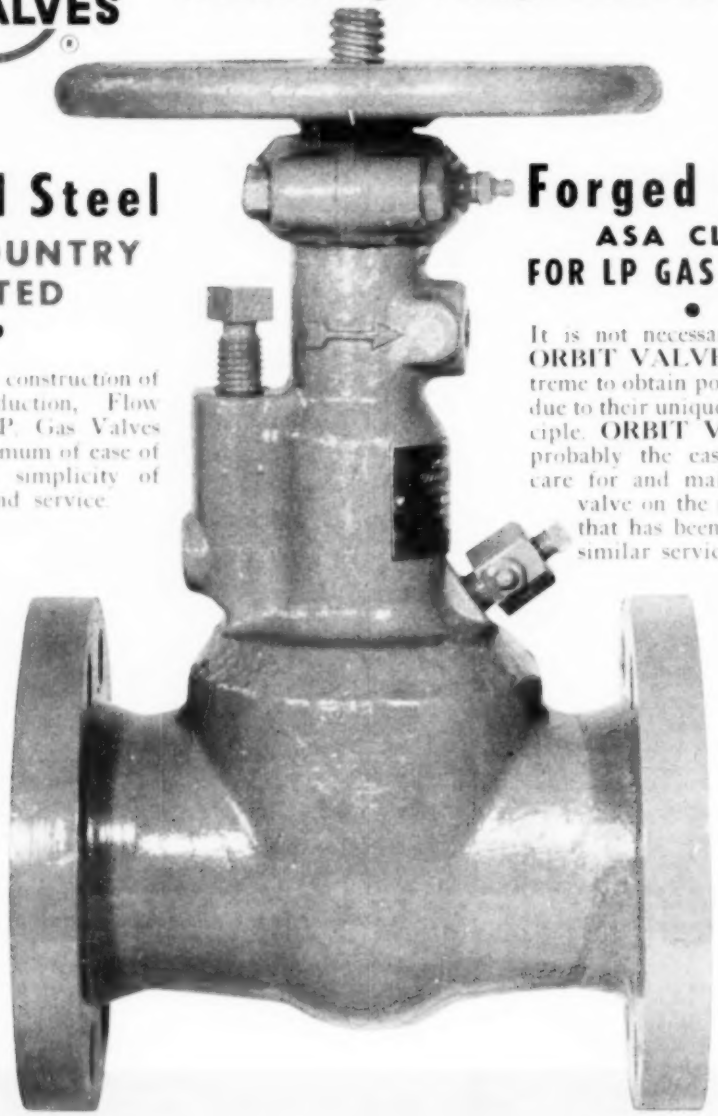

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Deterioration of Refining Equipment Discussed in Revised Corrosion Book

Corrosion, Causes and Prevention. Third Edition. By Frank N. Speller. 6 x 9 in. xiii + 885 pages. Illustrated. Appendix. Indexed. Stiff-cloth binding. $10.00. McGraw-Hill Book Co. Inc., New York and London.

Further exacting requirements of corrosion prevention have necessitated a third edition of this book. The author has deleted as much technical detail as possible in this revision, in an effort to present a more comprehensive view of the subject. Based mainly upon ferrous metals, the first part of the book delves into facts and factors already known about the theory of corrosion, together with the generally accepted electrochemical theory of corrosion, which has led to a system of classification of corrosion phenomena and the principles of corrosion testing.

A study of the various metals used in the manufacture of corrosion-resistant equipment is presented in relation to methods of their manufacture and treatment. The finishing operations of these metals, such as forging and rolling, are also considered extensively. It is pointed out, however, that methods of manufacture have much less to do with the ultimate life of iron and steel than the service conditions under which they are exposed.

In discussing the deterioration of petroleum refining equipment two general classes of corrosion are presented, 1) low-temperature corrosion in presence of water, as in distillation and cooling equipment, and 2) high-temperature corrosion (in which water may or may not take part) as in heater tubes, transfer lines, pressure stills, and reaction chambers operating above 500° F. (260° C.). Four ways are suggested for prolonging life of refinery equipment, viz., 1) additional thickness of metal, 2) more resistant metals, 3) alkaline neutralizers, and 4) protective linings, metallic or non-metallic.

A chapter on cathodic protection is most interesting, and is one of the new subjects presented in this edition. Cathodic protection is defined as "reduction or prevention of corrosion of a metal surface by making it cathodic by the use of sacrificial anodes or impressed currents." Cathodic protection has been developed in practice mainly on buried pipe lines for the past 20 years. More recently it has been employed successfully for the protection of bottom of crude oil storage tanks, water storage tanks, condensers, brine and seawater tanks, oil-well casing, and other cases where electrochemical corrosion could be encountered.

Frank N. Speller, well-known corrosion consultant, is the author. He has added a new section on biological influences of corrosion in addition to the one on cathodic protection.

Polluting the Air Viewed As Strictly Local Problem

Air Pollution. Proceedings of the United States Technical Conference on Air Pollution. Louis C. McCabe, Chairman. 7 x 10 in. xiv + 847 pages. Illustrated. Indexed. Stiff-cloth binding. $12.50. McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 18, N. Y.

Seven panels, contributing a total of 97 papers on all phases of air pollution, have made this volume one of the most authentic and interesting ones on the subject. In most cases, although many aspects of the pollution problems confronting the nation are discussed, no definite conclusions are drawn. The information presented gives a thorough accounting of conditions as they exist today.

Topics cover human, plant and animal health; measures and equipment necessary for prevention and control; and legal and administrative phases. At the conclusion of each paper (chapter), a discussion period ensues between authorities in the field on the relative merits of the papers presented. The informal comments of panel members make for very delightful reading.

In one of these discussions, the odor control practices used in refineries are shown closely allied with neighboring industries, e.g., burning city dumps, gas works, and other odoriferous places that contribute to the airborne dump overhead and around us. As pointed out in the discussion, odors are no respecters of company fences or any man-made boundaries.

George R. Hill of American Smelting and Refining Co., Salt Lake City, tells of the status of tall stacks in air pollution control. American's 605-ft. stack at Selby, Calif., is discussed. The gist of the talk is that there have been no complaints or marked vegetation from SO_2 since the tall stack went into operation. Mr. Hill remarks that "experience over the past 35 years has shown that air pollution control is strictly a local problem. While the stack effluents may be very similar, topography, wind direction, velocity, turbulence, and other meteorological factors may be widely different, even in locations in fairly close proximity to each other. Each problem needs to be studied locally before height or location of a stack can be determined with satisfactory accuracy."

An excellent account of the Donora, Pa., tragedy of 1948 is given, and details of the topography and meteorological conditions further substantiate the claims of Mr. Hill, i.e., that air pollution is strictly a local problem.

In 1949 President Truman formally authorized the Secretary of the Interior to organize an interdepartmental committee which would sponsor the United States Technical Conference on Air Pollution. The proceedings were to be made available to the public. Louis C. McCabe, chief, Fuels and Explosives Div., Bureau of Mines, U. S. Dept. of the Interior, was made chairman of the committee. Mr. Sidney Gottley of the Bureau of Mines, directed arrangements, edited manuscripts, and conferred with authors in regard to the many details that made the publication possible.

Engine Antifreeze Tests Compiled by ASTM

Sponsored by the American Society for Testing Materials, Committee D-15 on engine antifreezes, the first edition of *ASTM Standards on Engine Antifreezes* should prove of value to both producers and consumers interested in the antifreeze field. Nine methods for testing antifreezes include cover sampling and preparing aqueous solutions of engine antifreezes; freezing point of solutions; physical tests for boiling point of engine antifreezes, and specific gravity of concentrated antifreezes by the hydrometer; chemical tests for ash content and reserve alkalinity of concentrated engine antifreezes, and for water in concentrated engine antifreeze by the iodine reagent method. Specifications cover ASTM thermometers and hydrometer-thermometer field tester for engine antifreezes.

Copies of this 48-page publication, with heavy paper cover, can be procured from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $1.00 each.

Chemical Reference Series Starts With Aliphatics

Chemistry of Carbon Compounds. Vol. I, Part A, edited by E. H. Rodd. 5⅝ x 8⅜ in. xxi + 788 pages. Indexed. Stiff cloth binding. Subscription price $18.00. List price 15% higher. The Elsevier Press, 402 Lovett Blvd., Houston, Tex.

With the purpose of presenting a series of references, intermediate to *Elsevier* and *Beilstein*, the contributors to this compilation on organic chemistry regard these works as the successor to *Richter's Lexikon der*

Kohlenstoffverbindungen. This first volume encompasses the systematic presentation of organic chemistry dealing with aliphatic compounds. Unlike *Richter*, the series is concerned with the theoretical presentation of organic chemistry, together with its facts. In other words, the very language and nomenclature of organic chemistry is expressed in terms of contemporary theory.

There is a section devoted to synthetic methods of producing hydrocarbons, namely, the *Fischer-Tropsch* process. To those interested in the expanding field of petrochemistry, discussion of alkylation processes and polymerization of olefins is most thoroughly covered. Unsaturated hydrocarbons discussed are C_nH_{2n}, olefins or alkenes; C_nH_{2n-2}, acetylenes or alkynes, diolefins or dialkenes; C_nH_{2n-4}, olefin-acetylenes or alkenynes, triolefins or trialkenes; C_nH_{2n-6}, diacetylenes or dialkynes, diolefin-acetylenes or alkadienynes, and tetraolefins. A general index, additional to those in each volume, will be included in Volume V.

Dr. E. H. Rodd shouldered the responsibility of editing the treatise. He has been scientific liaison officer between the Dyestuffs Division of Imperial Chemical Industries Ltd. and the British Universities for two decades. Sir Robert Robinson, president of the Royal Society of London (1945-50) acted as chairman to the following group of advisers: Professors J. W. Cook, Glasgow; R. D. Haworth, Sheffield; Sir Ian Heilbron, London; E. L. Hirst, Edinburgh; and A. R. Todd, Cambridge.

Gulf's Progress Described In Anniversary Volume

Since Spindletop, by Craig Thompson. 8½ x 11 in., viii + 102 pages, illustrated, stiff cloth binding. Gulf Oil Corp., Pittsburgh, Pa.

Dedicated to Gulf people of the past and of the present, this nicely illustrated story tells of employes' contributions toward the growth and success of the Gulf Oil Corp. From January 10, 1901, when Anthony F. Lucas set up a new-fangled rotary drilling rig, laughingly dubbed "Spindletop," until the beginning of 1951, this story unfolds Gulf's rise to the select circle of American manufacturing corporations with assets of more than one billion dollars each.

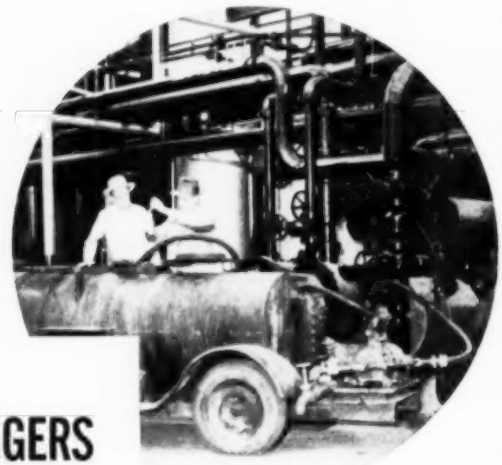
Man's knowledge of oil has increased vastly since "Spindletop" and is always on the threshold of some new adventure. With the next 50 years looking them in the eye, Gulf workers are saluted for past performances, with assurances of progress in years yet to come.

The author, Craig Thompson, was engaged by Gulf to write an impartial history of the organization. He was associated with *The New York Times* for many years and subsequently was in charge of a foreign office for *Time* magazine.

Fuel Production Periled In Soviet Held Countries

Fuel and Power in Captive Middle Europe, by Jan H. Wszelaki. 6 x 9 in., 63 pages, heavy paper cover, 25 cents. National Committee for a Free Europe, Inc., 110 West 57th St., New York City. (Bulk prices on request.)

Energy resources of captive countries in Middle Europe, now working under several long-range plans, are estimated up to the end of 1954 as 253.5 millions tons of coal equivalent. This includes lignite, petroleum, natural gas, and hydroelectricity in addition to coal output. The author points out that we should not underestimate the potential of these captive countries, namely, Eastern Germany, Czechoslovakia, Poland, Hungary, Rumania, Bulgaria, and Albania. Their target of 133 million tons of coal by 1954 can be compared to the output of bituminous coal in Pennsylvania in 1942 which reached 143 million tons. The reader is asked to take particular note of the fact



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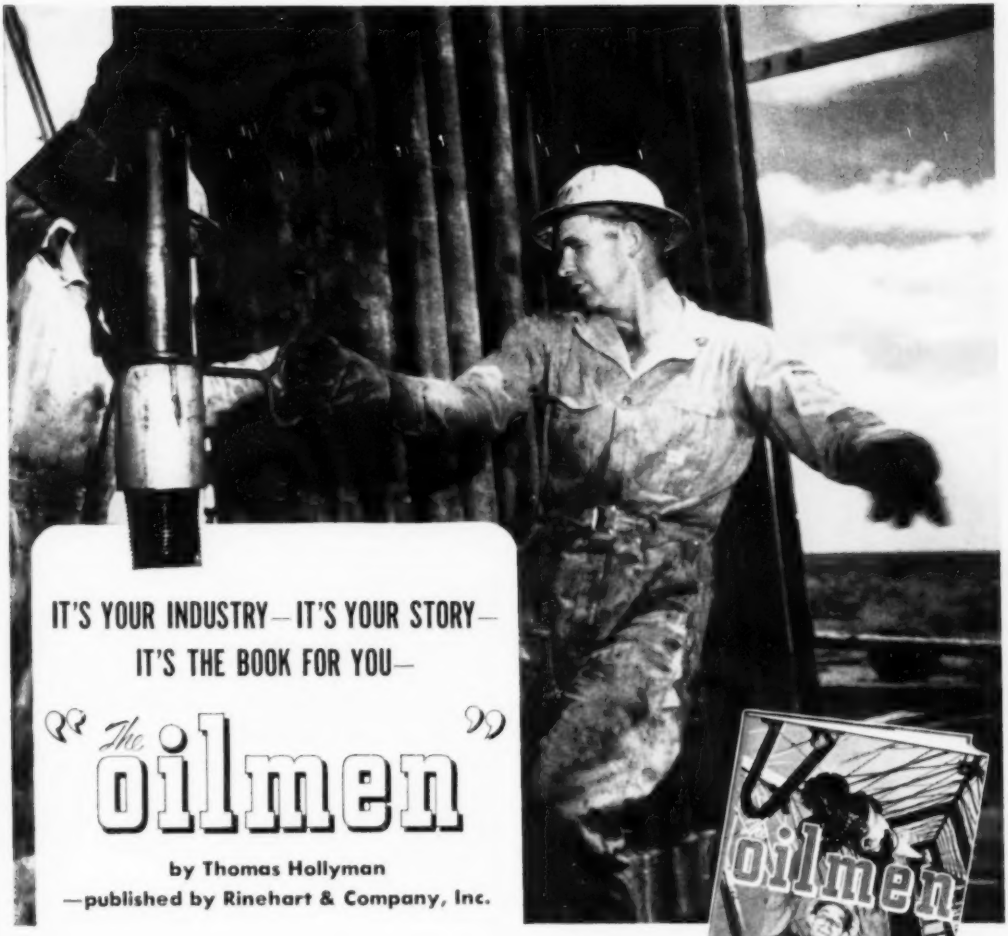

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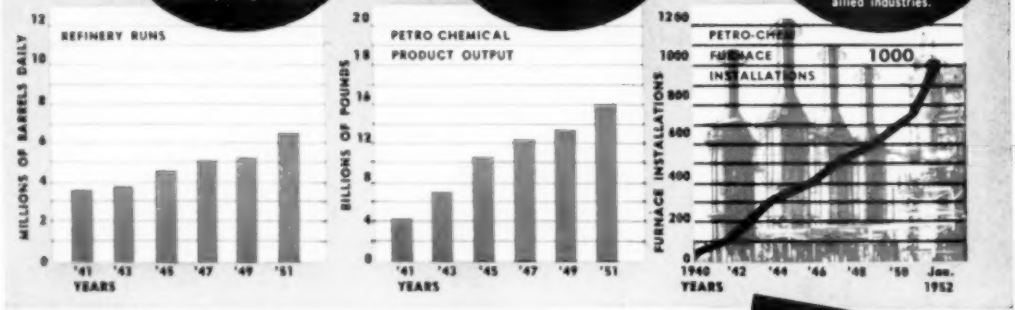

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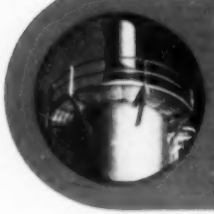

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that this study does not even hint at Russia's potential.

The Soviet is running into some difficulty in these countries. A food shortage, due to a long drought, has resulted in loss of much of the potato crop. This unforeseen circumstance threatens to disrupt the whole plan. Miners are badly fed as a result and actually are incapable of working as much as is expected of them. The lowered efficiency of the miners means less coal and less coal means less power, less machinery, and less chemicals.

The material is interestingly presented and gives us a *look* inside the Iron Curtain. Computations of the various energy resources were taken from statistical calculations of the United Nations.

The author, Jan Wszelaki, is a former member of the Polish diplomatic service (1918-1945). Prior to the war he was Secretary and Counselor, with the rank of Minister, at the Polish embassies in London and Washington. He was educated in Moscow and Paris, and is a specialist in economic affairs.

Technology Reviews of '49 Note Petrochem Influence

Reviews of Petroleum Technology, Volume II covering 1949, edited by George Sell. 6 x 9 inches, with 288 pages, printed. 27 s. 6 d. (approximately $3.80). The Institute of Petroleum, 26 Portland Place, London, W.1.

In this eleventh volume of *Petroleum Technology* there is a chapter dealing with plant instrumentation from 1947 to 1949. This period saw radioactivity employed more widely in practical instrumentation, electropneumatic control systems received some attention, and inter-connected control systems were used to an increasing extent. What were then new developments, e.g., electronic potentiometers, force-balance diaphragm flow transmitters, etc., are now regarded as standard practice for many applications.

Of considerable merit is the chapter devoted to special products. With the ever increasing trend of producing chemicals from petroleum and natural gas, this chapter stands out at this time in its discussion of various processes, such as the Fischer-Tropsch, the OXO and Synol processes. Patent information refers to olefins, and includes the conversion of α or β-olefins into ketones by absorption in a mercury salt solution followed by acid decomposition, and an alternative procedure involving the formation of an unsaturated ketone by catalyzed reaction with acetic anhydride, followed by mild hydrogenation to a saturated ketone, more severe reduction to a secondary alcohol is claimed. The direct conversion of olefins to ethers is the subject of another patent employing an anhydrous-fluoride-catalyzed reaction with alcohols.

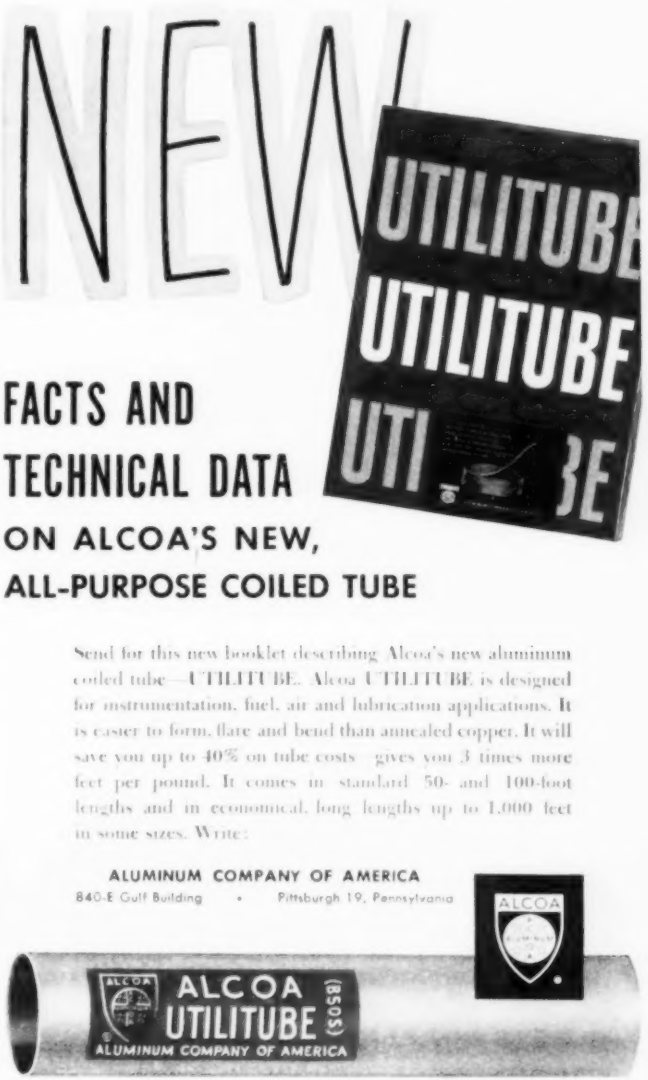
The preparation of nitro-paraffins, recovery of elemental sulfur from hydrogen sulfide, and recovery of aromatics from petroleum are also discussed.

The volume contains references to nearly 3,000 technical papers and articles. Acting as honorary editor and honorary associate editor respectively, were F. H. Garner and E. B. Evans. The editor is George Sell.

Government Publication

Methods of Measuring Humidity and Testing Hygrometers. National Bureau of Standards Circular 512, by Arnold Wexler and W. G. Brombacher; ii + 38 pages, illustrated, heavy paper cover.

Copies can be ordered by sending 15 cents with your request to the Government Printing Office, Washington 25, D. C.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Send for this new booklet describing Alcoa's new aluminum coiled tube—UTILITUBE. Alcoa UTILITUBE is designed for instrumentation, fuel, air and lubrication applications. It is easier to form, flare and bend than annealed copper. It will save you up to 40% on tube costs—gives you 3 times more feet per pound. It comes in standard 50- and 100-foot lengths and in economical, long lengths up to 1,000 feet in some sizes. Write:
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(To obtain more data on advertised products see page 696)

YOUNG *All the Way!*

FROM WELL...

...TO GASOLINE PLANT

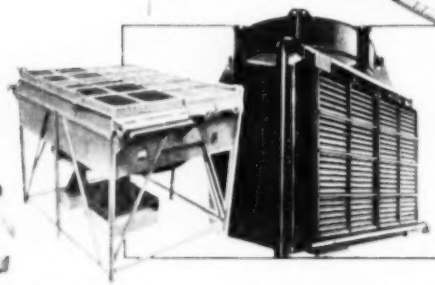
MONO-WELD Heavy Duty Steel Radiator

Plant and Removable Tube and Bundle Heat Exchangers

"MONO-WELD" Radiators are available for cooling jacket water or for cooling jacket water and lube oil in a single unit. They are especially suitable for skid-mounted equipment and have welded steel tank and side member construction. Tube and bundle heat exchangers are particularly well adapted to applications where compactness is at a premium.

Heavy Duty "FULL FLOW" and Standard Series Jacket Water Coolers

Remote locations require dependable, trouble-free cooling units, easy to maintain. Sturdily constructed "FULL FLOW" Jacket Water Coolers with removable sections (optional) make it possible to repair and replace easily. Accessories: motors, idlers, pumps, surge tanks, controls, shutters, etc.



Young HC (left) and VAD Vertical Air Discharge Cooling and Condensing Equipment

These large units can take care of your biggest cooling job. Versatility is a keynote—standard models provide for water, gas or oil cooling, steam or vapor condensing in any combination. Accessories available: motors, controls, shutters, gear boxes, etc.

...TO REFINERY

Young Radiators For All Automotive Applications

Young serves every phase of the oil industry. Many manufacturers of oil transport and delivery equipment specify Young Radiators for gasoline and Diesel equipment. These radiators are carefully engineered for the specific job, as is the heat transfer equipment for the biggest oil field jobs.

...TO CONSUMER

1927-1952 25 YEARS OF PROGRESS in Heat Transfer Engineering

YOUNG

Heat Transfer Products for Automotive and Industrial Applications.

Heating, Cooling, Air Conditioning Products for Home and Industry.

YOUNG RADIATOR COMPANY

Dept. 267-E • RACINE, WISCONSIN

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LOS ANGELES: Flournoy & Everett, Inc.
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206 Montgomery Bldg.

Other Representatives in Principal Cities

Symposium to Cover New Developments in Process Industries' Instrumentation

The school of Engineering, Chemical Engineering Department, Agricultural and Mechanical College of Texas, will present the seventh symposium on "Instrumentation for the Process Industries" on June 2, 3, and 4th, at College Station, Texas. All interested in the subject are invited to attend. The registration fee is $6.00 per person and entitles the registrant to attend all the lectures and to receive a printed copy of the proceedings, to be mailed after the course is completed. Additional charges will be made for room rent, banquet and the social evening.

Subject matter of the symposium will be limited so that the primary emphasis will be placed on applications to continuous fluid flow processes. Particular attention will be given to new developments. The afternoon of June 4 will be entirely a question and answer period. When written questions are disposed of, verbal questions from the floor will be in order. There will be equipment exhibits of an educational nature housed in the Student Memorial building. Exhibits will be closed while the regular sessions are in progress.

About 80 hotel rooms are available in the Student Memorial building wherein the sessions will be held. Prices for these rooms are $4.00 for a single and $6.00 for a double. The Casa Loma Motel, Highway 6, Bryan, Tex., has also been reserved for those in attendance. Communications concerning room reservations in the Student Memorial building should be addressed to Mrs. Mozelle Holland, guest rooms manager, Memorial Student Center, A. and M. College of Texas, College Station, Tex.

The program tentatively lined up is as follows:

June 2—Session I (morning)

1. Keynote Address.
2. "Instrumentation of Industrial Waste Treatment Processes."

Session II (afternoon)

3. University Training in Instrumentation.
4. On-the-Job Training in Instrumentation.

June 3—Session III (morning)

5. Survey of Gas-Liquid Analyzers.
6. Instrumentation of a New Type Hydrogenation System.

Session IV (afternoon)

7. Instrumentation Flow Sheets.
8. Further Extraction of Lubricating Oils.

June 4—Session V (morning)

9. Butterfly Valves.
10. Weighering in Chemical Plants.

Session VI (afternoon)

11. Question and Answer Session.

ASTM's Anniversary Meeting Has 30 Sessions

TO ACCOMMODATE the large number of technical papers on the properties and testing of materials which are to be presented at its 50th Anniversary Meeting in New York City, June 23-27, the American Society for Testing Materials has already scheduled 30 technical sessions. Headquarters will be at the Hotels Statler and New Yorker. All exhibits will be at the Statler.

Chief speaker at the Annual Dinner, Wednesday, June 25, will be Dr. Detlev W. Bronk, president of the National Academy of Sciences.

Five papers, sponsored by Committee D-19, will be presented Tuesday, June 24, on "Continuous Analysis of Industrial Water and Industrial Waste Water." They are: *Continuous Recording of Chlorine Residuals and Determination of Chlorine Demand*, by A. E. Griffin, Wallace & Tiernan Co., Inc.; *Automatic Sampling of Industrial Water and Industrial Waste Water*, by M. F. Madarasz, Ford Motor Co.; *Some Practical Aspects of the Measurement of pH, Electrical Conductivity and Oxidation-Reduction Potential of Industrial Water*, by Robert Rosenthal, Industrial Instruments, Inc.; *Continuous Measurement of Dissolved Gases in Industrial Water*, by J. K. Rummel, Sheppard T. Powell; *Measurement of Color, Turbidity, Hardness, and Silica in Industrial Waters*, by F. C. Staats, Hercules Powder Co.

API Lubrication Committee To Hear 7 Speakers

SEVEN speakers have been lined up for the next meeting of the Lubrication Committee of the American Petroleum Institute. The meeting will be held at the Mayo Hotel in Tulsa, Okla., May 26-28. Ben G. Symon, manager of Shell Oil Co.'s lubricants department, is chairman of the committee.

Six of the speakers will address the general session on May 27th. Mr. Bruce Boehm, Enjay, Inc., New York, is scheduled to discuss *Factors in the Additive Treatment of Top Quality Motor Oils*. Mr. D. F. Hollingsworth, The duPont Co., Wilmington, Del., will deliver *The Importance of Lubrication to Industry Management*. Mr. R. W. McDowell, president of Mid-Continent Petroleum Corp., Tulsa, will deal with *Lubricants and Their Importance to the World*. Mr. E. T. Knight, Atlantic Refining Co., Philadelphia, will discuss the subject of supply, demand and general economics affecting the lubricants industry. M. D. Gjerde, Standard Oil Co. (Ind.), Chicago, and H. C. Mougey, General Motors Research, Detroit, are the other two scheduled speakers.

Dr. Harold Vagtbourg, president of the Southwest Research Institute, San Antonio, Tex., will be the speaker for the Tuesday evening banquet.

Among the items on the agenda for the business meeting are further discussion of the new motor oil designations, and an educational program.

Oil Man's Calendar

MAY

Deutsche Gesellschaft fur chemisches Apparatewesen, chemical apparatus and equipment exhibition, Frankfurt am Main, Western Germany, May 18-25.

Office of Naval Research and Western Reserve University, symposium on Acoustics and Chemistry, Western Reserve University, Cleveland, O., May 21-23.

Society for Applied Spectroscopy, 5th annual meeting, Hotel McAlpin, New York, N. Y., May 26-27.

Packaging Institute, Commodore Hotel, New York, N. Y., May 22-24.

American Society for Quality Control, sixth annual convention, Syracuse, N. Y., May 22-24.

Special Libraries Assn., Petroleum section of the 50th Conference, Hotel Statler, New York, N. Y., May 26-27.

American Petroleum Institute, Lubrication Committee meeting, Mayo Hotel, Tulsa, Okla., May 26-28.

JUNE

Society of Automotive Engineers, summer meeting, Automotive and Body Council, Hotel Ritz, Atlantic City, N. J., June 1-5.

A. and M. College of Texas, School of Engineering, Chemical Engineering Dept., "Instrumentation for the Process Industries," College Station, Tex., June 2-4.

Chemical Institute of Canada, 35th annual conference, Montreal, Que., June 3-4.

Chemical Specialties Manufacturers Assn., midyear meeting, Copley-Plaza Hotel, Boston, Mass., June 8-10.

International Organization for Standardization, technical meeting, Columbia University, N. Y., June 9-12.

American Petroleum Institute, midyear division meeting, Roney Plaza Hotel, Miami Beach, June 9-11.

American Society of Mechanical Engineers, semi-annual meeting, Sheraton-Gibson Hotel, Cincinnati, O., June 15-19.

American Society for Testing Materials, 50th anniversary meeting, Statler and New Yorker Hotels, New York, N. Y., June 23-27.

American Institute of Electrical Engineers, summer general meeting, Statler Hotel, Minneapolis, Minn., June 23-27.

JULY

University of California, National Conference on Glass and Clay Technology, Berkeley Campus, Berkeley, Calif., July 21-25.

AUGUST

Society of Automotive Engineers, West Coast meeting, Hotel Fairmont, San Francisco, Calif., August 11-13.

DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS

This Refinery asked:

Can you clean catalytic cracker equipment?

Dowell Service **cleaned slurry exchangers—through-put increased 6,000 barrels a day!**

Through-put on a fluid catalytic cracker in a large refinery was reduced because deposits badly fouled the slurry exchangers. Dowell Service cleaned the shell side of these exchangers in less than 12 hours. As a result of the cleaning, the operator was able to step up the through-put on the cracking unit from 16,000 to 22,000 barrels per day. This increased efficiency also made it possible to postpone a proposed shut-down for a major overhaul of the unit.

On another catalytic cracker, the increased through-put resulting from Dowell Service had an estimated value of $4,300 per day.

All types of equipment on catalytic crackers have been cleaned effectively by Dowell Service methods . . . *without dismantling and with a minimum of down-time.* Dowell furnishes trained personnel and all necessary equipment. Dowell engineers apply liquid solvents according to the technique demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing. These solvents are designed to remove deposits quickly, efficiently and economically. Often equipment may be cleaned while it is in operation.

Call Dowell for assistance on your maintenance cleaning problems. Dowell Service is applicable to condensers, process towers, pipe lines, storage tanks, boilers, cooling jackets and other refinery equipment. Experienced Dowell engineers will be glad to consult with you. No obligation, of course. Phone the nearest Dowell office today.

Other recent Dowell jobs:

Dowell Service cleaned a steam driven turbine blower surface condenser. After cleaning, heating efficiency increased almost 200%. Higher vacuum permitted greater speed on blower.

•

Three waste heat boilers were Dowell cleaned. Following this fast, efficient service, these boilers produced 23% more steam per hour with an estimated $49 per day payout to refinery.

•

In just one day, Dowell Service thoroughly cleaned heavy ferrous ferrocyanide deposits from a bubble cap rectifier column. This column was restored to top operating efficiency.

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Jacksonville 2	Oklahoma City 2	Anniston, Alabama	Midland, Texas
Buffalo 2	Houston 2	Hattiesburg, Miss.	Wichita Falls, Texas
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★ *Maintenance cleaning service for industrial heat exchange equipment.*

★ *Chemical services for oil, gas and water wells.*

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A Service Subsidiary of

THE DOW CHEMICAL COMPANY

Few Weeks' Strike Would Burden Summer Operations, Stock Buildup

THE strike of refinery operators, if it lasted only a few weeks and with only about a third of refining capacity affected, would throw off balance the normal trend of plant operations and stock changes in future months. Coming at the start of the season of heavy consumption, gasoline demand within a week of the start of the strike, was already feeling a reduction in refinery output, perhaps better than 1,000,000 b/d.

With the close of the heating oil season at hand and with stocks at the high levels of early May, an indicated reduction of around 600,000 bbls. daily in kerosine and distillate output will likely not affect current demand for this product. The rate of buildup of stocks against next season's demand, with a strike of any long duration, will be of more concern to the industry.

During the summer months heating oil stocks normally build up at the rate of 400,000 to 500,000 bbls. a day. Anything less than this rate of increase in stocks this season would present a serious problem to the industry next fall, in view of a predicted increase in heating oil demand in 1952-53 of about 10% over the current heating oil season. At the rate of residual fuel production at refineries, and the relatively low stock levels, any continued reduction in the supply of this product will affect demand and may have the result of speeding up changeover from oil to coal in many industrial plants.

While stocks of principal refined products at refineries and bulk terminals as of April 30 are the highest on record, except for residual fuels, these totals are misleading if it is considered the material is all available to make up for the cut in current plant output caused by the strike. A large portion is working stocks in tanks and pipelines and cannot be reduced below a certain minimum. An extended strike will mean dislocation of supply channels with stock reductions being at greater rates in some areas than others. The pull on stocks in the tanks of local oil companies, so-called secondary stocks, which are always an unknown factor, may soon mean greater withdrawals of primary stocks in refineries.

Gasoline stocks of 155,367,000 bbls. on April 26, represent about a 44 days supply in terms of forecast demand for the next two months of around 3,500,000 b/d avg. About 9,000,000 bbls. of this is due to a broadening of the definition of primary stocks by reporting authorities (See accompanying note). With one third of refinery capacity struck, current production of gasoline is at a rate of about 1,500,000 b/d under normal demand as of early May. Gasoline stocks, even at present levels, will be sharply reduced if the strike is of long duration.

Preliminary figures on refinery operations for the first quarter of 1952 show an increase in crude run to stills of 3.2% from the first three months of 1951. (See accompanying tables.) Production of gasoline at refineries was 6.7% higher and total supply of motor fuel about 6.5% greater. Indicated motor fuel demand at refineries was nearly 8% larger in the current first quarter.

Indicated production of kerosine for the first quarter was slightly less than the first three months of 1951, production of distillates was 6.4% larger. Total supply of heating oils was about 4% larger. Total demand for heating oils was 9% greater than in the first quarter of '51. For the current first quarter, indicated refinery production of residual fuel oil was nearly 3% less than for the 1951 quarter. There was only a nominal difference in imports and total supply was about 2.2% less. Indicated residual fuel demand for the first quarters of 1951 and 1952 were about the same, preliminary data indicates.

The Bureau of Mines reports that under normal conditions crude oil runs to refinery stills in the second quarter would be below its previous forecasts, due to the supply of all oils in the first quarter being larger than forecast, with a total decline in product stocks in that period of only around 30,000,000 bbls., as against 40,000,000 bbls. decline forecast.

Change in Inventories

The volume of product inventories currently shown in refineries, bulk terminals and pipelines (primary storage) reflects a broadening of the definition of bulk terminals by the API and the Bureau of Mines. Previously, a bulk terminal was considered any installation that shipped to other distributing points 50% or more of the material passing through it. Changing distribution practices has resulted in many terminals moving a larger proportion of their material into consumption channels and it was felt their inventories should be included in primary storage.

About 9,000,000 bbls. more gasoline, 1,500,000 bbls. more kerosine, more than 3,000,000 bbls. of distillate fuels and about 1,500,000 bbls. more residual fuel oil were included in primary stocks' figures, starting April 5, as a result of the new definition of a bulk terminal.

Considering both primary storage and secondary storage (local oil distributors' tanks) the change does not represent an increase in overall inventories.

Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
April (2 API)			
April (BM)			
1 Mo.			
4 Months			

(Revised, April 28)

Total (1000 bbls.)

(Revised, 28 March 1952)

March			
March			
3 Months			
4 Months			

(Revised, April 28)

BM Forecast of Crude Runs to Stills, 1952

(Revised, 28 March 1952)

Yields on Crude Runs to Stills

	Gasoline	Kerosine	Dist. Fuels	Resid. Fuels
	%	%	%	%
April (2 API)				
March (2 API)				
3 Mo. (BM)				
Year (BM)				

(Revised, April 28)

Fig. 1—Crude Runs Slacken in April

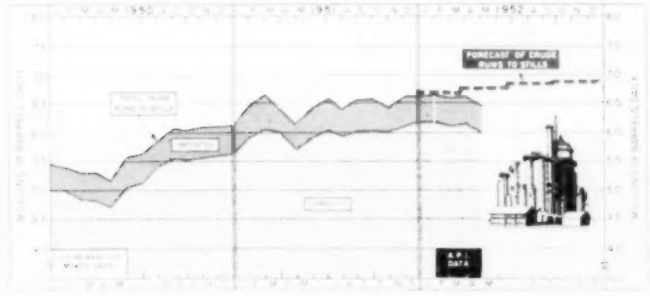
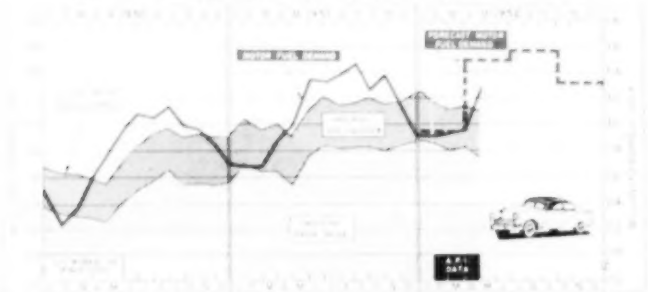
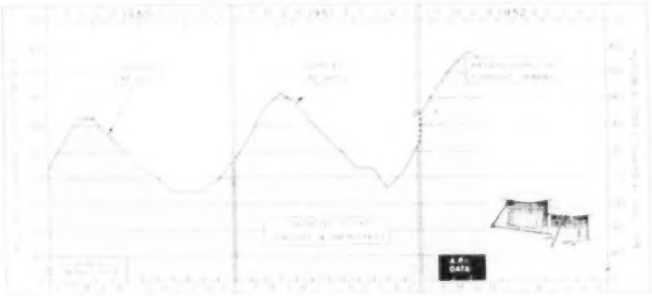


Fig. 2—Sharp Gain in Motor Fuel Demand



* Natural Gas Liquids include gasoline blended at refineries, and that used as finished motor fuel.

Fig. 3—New Figures for Gasoline Stocks



* New basis, see text.

Fig. 4—Seasonal Drop in Heating Oil Output

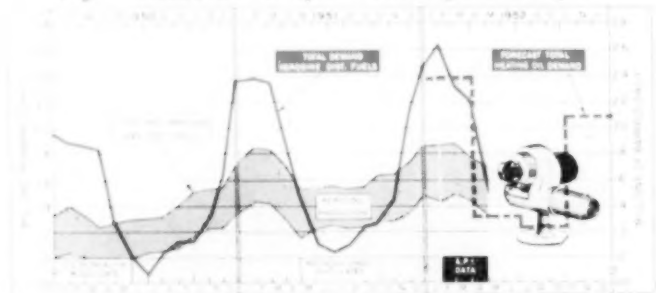
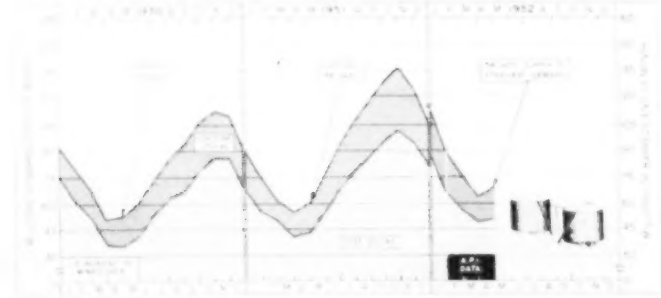


Fig. 5—Heating Oil Stocks Start Build-Up



* New basis, see text.

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline	Natural Blended		
	Straight Run & Cracked	Gasoline	Used Direct	TOTAL
April '52 API*				
April '52 BM				
± Change				
± Change %				
4 Months Ended April 30				
Total (1000 bbls.) (Bureau of Mines Data)				
May '51				
May '52				
± Change				
± Change %				

* Based on API Data

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

April '52 API*	
April '52 BM	
± Change	
± Change %	
4 Months Ended April 30	
Total (1000 bbls.) (Bureau of Mines Data)	
May '51	
May '52	
± Change	
± Change %	

* Based on API Data

BM Forecast of Motor Fuel Demand, 1952

Nov. '52	Dec. '52	Jan. '53	Feb. '53	Mar. '53

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

April '52 API*	
March '52 API	
± Change	
April '52 BM	
April '51 BM	
± Change	
± Change %	

* New basis, see text.

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
April '52 API*			
April '52 BM			
± Change			
± Change %			
4 Months Ended April 30			
Total (1000 bbls.) (Bureau of Mines Data)			
May '51			
May '52			
± Change			
± Change %			

* Based on API Data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
April '52 API*			
April '52 BM			
± Change			
± Change %			
4 Months Ended April 30			
Total (1000 bbls.) (Bureau of Mines Data)			
May '51			
May '52			
± Change			
± Change %			

* Based on API Data

BM Forecast of Heating Oils Demand, 1952

Nov. '52	Dec. '52	Jan. '53	Feb. '53	Mar. '53

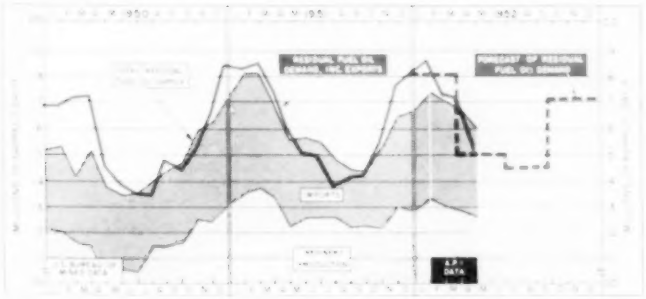
Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
April '52 API*			
March '52 API			
± Change			
April '52 BM			
April '51 BM			
± Change			
± Change %			

* New basis, see text.

Fig. 6—Residual Fuel Oil Production Drops



Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
March '52 AFD*			
April '52 AFD			
Change			
% Change			
Previous April 30			
Total (1000 bbls.)			
(Percent of Motor Fuels)			
Mar. '52			
Mar. '51			
Change			
% Change			

*Motor Fuels AFD basis.

Residual Fuels Demand

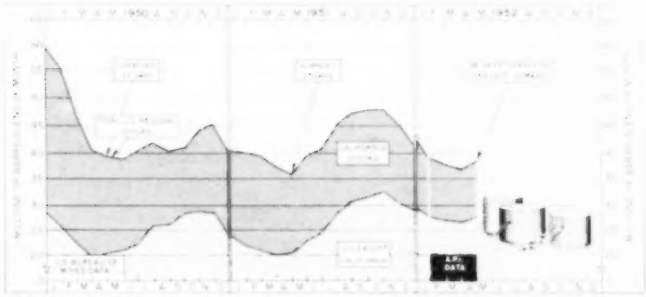
Daily Average (1000 bbls.)

April '52	
April '51	
Change	
% Change	
Previous April 30	
Total Demand (1000 bbls.)	
Mar. '52	
Mar. '51	
Change	
% Change	

Motor Fuels AFD basis.

BM Forecast Residual Fuels Demand, 1952

Fig. 7—Small Gain in "Resid" Stocks in April



Residual Fuel Stocks

(1000 bbls. end of month)

	U. S. Except California	Total U. S.
March '52 AFD*		
April '52 AFD		
Change		
% Change		
April '51		
Change		
% Change		

*New basis, see text

Fig. 8—Production and Demand of Natural Gas Liquids

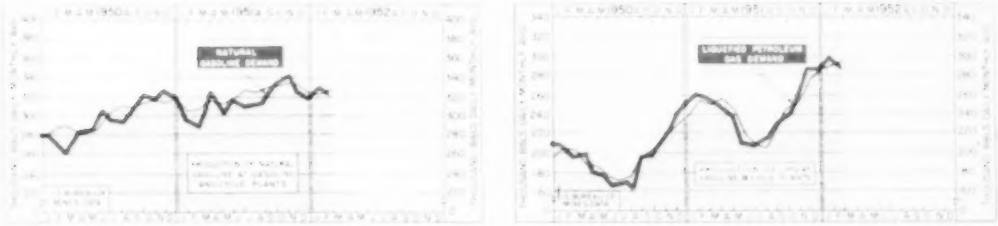
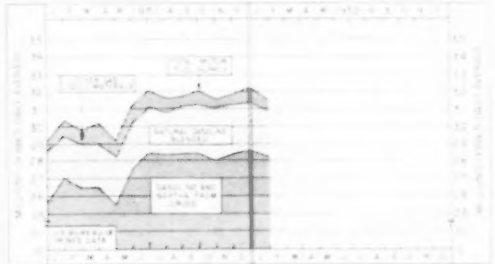


Fig. 9—Stocks of Natural Gas Liquids



	Gasoline & Naphtha-type Comb.	Natural Blended	Other Gas Liquid Materials	Total Motor Fuel Supply
Jan. '52				
Dec. '51				
Nov. '51				
Jan. '51				

Natural Gas Liquids Statistics

Production (1000 bbl. day avg.) — Demand (1000 bbl. day avg.)

	Natural Gasoline*	LPG	TOTAL	Natural Gasoline	LPG**	TOTAL
Jan. '52						
Dec. '51						
Nov. '51						
Change						
% Change						
Total Production (1000 bbl.)				Total Demand (1000 bbl.)		
Jan. '52						
Jan. '51						
Change						
% Change						

Stocks, End of Month (1000 bbl.)

	By Type of Product — At gasoline plants and terminals only				By Location — Refineries	Gasoline Plants	TOTAL
	LPG	Natural Gasoline	Conden-sate	Finished Gasoline†			
Jan. '52							
Dec. '51							
Jan. '51							

*Natural gasoline and condensate. **LPG includes that produced from natural gasoline plants and that produced from refinery operations. †Finished gasoline and other products.

ADVERTISERS' INDEX

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

●

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(A5) ALUMINUM CO. OF AMERICA 669
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(C6) DOWELL, INC. 662
(C7) DU PONT DE NEMOURS & CO., INC., THE E. I. Facing 660 661
(C8) DU PONT DE NEMOURS & CO., INC., THE E. I. 666
(C9) DURAMETALLIC CORP. 661
(D1) ENTOLETER, INC. 706
(D2) ETOYL CORP. Facing Inside Front Cover
(D3) FABRIC ENGINEERING CORP. 705
(D4) FILTROL CORP. 654
(D5) FISCHER & PORTER CO. 663
(D6) FLINT STEEL CORP. 704
(D7) FLUOR CORP., LTD., THE 671
(D8) FOSTER WHEELER CORP. 671
(A3) GENERAL CHEMICAL DIV., ALLIED CHEMICAL & DYE CORP. Inside Back Cover
(D9) GLOBE STEEL TUBES CO. Facing 660
(E1) GRAVER TANK & MFG. CO., INC. 656
(E2) GREINER CO., THE EMIL 666
(E3) HARTZELL PROPELLER FAN CO. 662
(E4) HASTINGS INSTRUMENT CO. 666
(E5) HAYS CORP. 647
(E6) HOOKER ELECTROCHEMICAL CO. 663
(E7) HUDSON ENGINEERING CORP. Inside Front Cover
(E8) INSTRUMENTS, INC. 704
(E9) JOHNS-MANVILLE CORP. 662
(F1) KELLOGG CO., THE M. W. 661 666
(F2) KIESLER & MUELLER 652
(F3) KOCH ENGINEERING CO. 704
(F4) LUMMUS CO., THE 646
(F5) McKEE & CO., ARTHUR G. 662
(F6) METAL TEXTILE CORP. 704
(F7) MINNEAPOLIS-HONEYWELL REGULATOR CO. 646 647
(F8) MONSANTO CHEMICAL CO. 655
(F9) NATIONAL AIROIL BURNER CO. 646
(G1) NATIONAL ILLUMINATE CORP. 654
(G2) NICHOLSON & CO., W. H. 661
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(G4) NORTON CO. 676
(G5) OAKITE PRODUCTS, INC. 666
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(H9) RUST-OLEUM CORP. 661
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(I8) TENNESSEE EASTMAN CO. 658
(I9) THERMO ELECTRIC CO., INC. 706
(J1) TRANE CO., THE 667
(J2) U. S. STONEWARE CO. 673
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(J4) VERNON TOOL CO., LTD. 671
(J5) VOIT MACHINE CO., HENRY 705
(J6) VULCAN COPPER & SUPPLY CO. Facing 661
(J7) WARNER LEWIS CO. 704
(J8) WATSON-STILLMAN CO. 700
(J9) WESTERN SUPPLY CO. 662
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(K3) WOLVERINE TUBE DIV. 666
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(K6) YOUNG RADIATOR CO. 666

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FOR "WHAT'S NEW" PRODUCT INFORMATION
Circle the code number on the card below which corresponds to the number listed at the end of that specific "What's New" item.

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Issue of May, 1952

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A1	B1	C1	D1	E1	F1	G1	H1	I1	J1	K1	L1	M1	N1	O1	P1
A2	B2	C2	D2	E2	F2	G2	H2	I2	J2	K2	L2	M2	N2	O2	P2
A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	K3	L3	M3	N3	O3	P3
A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	K4	L4	M4	N4	O4	P4
A5	B5	C5	D5	E5	F5	G5	H5	I5	J5	K5	L5	M5	N5	O5	P5
A6	B6	C6	D6	E6	F6	G6	H6	I6	J6	K6	L6	M6	N6	O6	P6
A7	B7	C7	D7	E7	F7	G7	H7	I7	J7	K7	L7	M7	N7	O7	P7
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Company _____ Business Address _____

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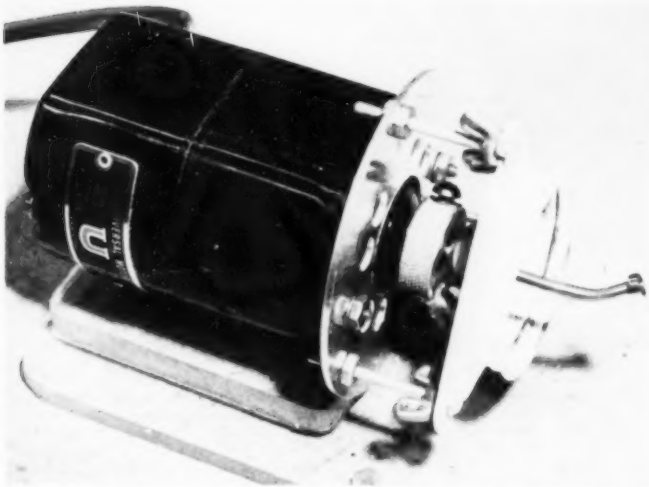
WHAT'S NEW . . .



COMPRISED OF ONLY THREE PARTS this pump handles liquids containing up to 20% vapor without loss of efficiency

Pump Works on Vibration Principles

Essentially a centrifugal pump, the "Vibro-Pump" employs the principles of vibration rather than rotation. It differs from centrifugal pumps in the following ways: 1) size; 2) orbital rather than a revolutionary motion of the impeller or activator; 3) the complete absence of packing of any type; 4) permanent lubrication of the single bearing, the only point of contact between motor and vibro-pump; 5) clearances heretofore impossible between impeller and pump housing; and 6) elimination of the necessity of high-torque motors. Sand, mud, slurry and other foreign matter are handled easily. The pump is hermetically sealed, ideal for the chemical, oil, and gasoline industries, and a variety of commercial applications. It is comprised of only three parts: 1) a slightly curved shaft extending from a motor coupling, 2) a single unit consisting of the impeller housing and vane, and 3) the pump housing. Impressed upon the curved shaft in one design is a permanently lubricated frictionless bearing which is permanently sealed in the metal bellows or rubber impeller housing and vane unit. As the shaft rotates it imparts to the vane an orbital motion. The wave-shaped vane remains in a horizontal plane, scooping the liquid from the pump center while pushing it to the housing perimeter. It is this unique action that permits liquids containing up to 20% vapor to be passed through the pump without loss of efficiency. It further eliminates the possibility of vapor lock. Surprisingly high pressure and high vacuum for centrifugal pumps are registered by the several models that have been tested. For instance, a small water pump with a 1-½ in. diameter housing and a 1-in. impeller orbit powered by a 1/25 hp motor at 4000 rpm., developed a head of 35 ft. A 3-in. diameter pump powered by a 1/6 hp motor at 3600 rpm. created a suction of 27 in. Hg. Bennett Productions, 1507 Walnut St., Philadelphia 2, Pa.

Circle No. 1 on Reply Card

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.

Continuous Packing Available For High or Low Temperatures

A new, continuous, chevron-type packing, designed for 500-6000 psi., is now available for either high or low temperature service. Known as Flexrock "Continuous-Vee" Packing, it is furnished in sizes from ¼ in. to 1 in. by 1/16 in. increments, 25 ft. per spiral. The packing is offered in two styles: No. 2005 is constructed of the best asbestos cloth and neoprene, and is recommended for high temperature service on reciprocating steam or air rods, and hot oil pumps. No. 2008—for lower temperatures—is made of the best cotton duck and neoprene and is recommended for hydraulic rams outside packed plunger pumps, and other equipment which handles oil or water. Flexrock Co., Mechanical Packing Div., 3670-E Cuthbert St., Philadelphia 4, Pa.

Circle No. 2 on Reply Card

Coating Wire Fences with Roller Saves Material, Time and Money

In developing an economical method of fence coating application, a special, long-nap, lambs-wool roller, thoroughly saturated with "Rust-Oleum" was found to do the trick. As illustrated, the roller is dipped into the container of material and is pulled up on a flat board surface of approximately the same width as the roller to remove running surplus material. Then the roller is applied to the area to be coated. Even the barbed wire on top of the fence can be rolled on, although the pipe framework and supporting arms holding the barbed wire are best done by

brushing after the fence has been rust-coated. Results of this method show that there is little waste of material by splashing, drippings, or spray. The time of a fence painting job is cut practically in half, thus saving in man-hours. Therefore the longer the fence, the greater the savings. It is recommended that the rusted sections of the fence be primed first, then coated with aluminum. Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

Circle No. 3 on Reply Card

Plastic Coating Protects Process Equipment from Corrosive Force

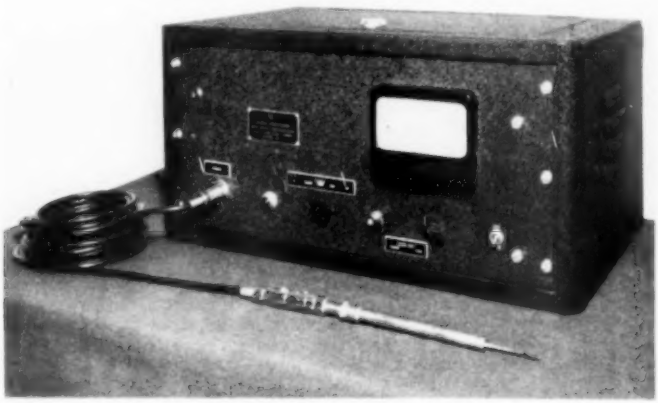
A protective coating which employs specially made plastic may be brushed on a surface, sprayed or dipped, and will dry to a flexible coating that will not crack. The manufacturer states that "Leak Lock" is effective at temperatures from subzero to 400° F. It adheres tenaciously to most surfaces and may be used to protect process equipment, piping, tanks, and fittings against a wide variety of chemicals, e.g., paint solvents. "Freons," carbon tetrachloride, trichlorobenzene, perchloroethylene, ethylene dichloride, and ortho-dichlorobenzene. No curing is required. When air dried, the coating has a smooth, glossy finish and retains much flexibility. It is claimed that scratches or blows will not crack or peel the coating. The product is available in pints and 10-lb cans. Highside Chemical Co., 10 Colfax Ave., Clifton, N. J.

Circle No. 4 on Reply Card

Oil-Resistant Tape Provides for Greater Dielectric Strengths

Designated "Scotch" brand electrical tape No. 23, a new oil-resistant fiber tape is suitable for rapid insulation build-up on splices in large power cables. The 40-mil thickness and extreme stretch (300%) breaking point make possible smooth insulation wraps on irregular surfaces. Dielectric strength is 15,000 volts unstretched, and 10,000 volts at 500% elongation. It has an electrolytic corrosion factor of 1.0 and an insulation resistance of 100,000 megohms. The tape is available in ¾ in. x 15-ft. rolls, is green-colored, and has a white strippable liner to be removed before use. Since it flows to itself forming a solid homogeneous mass, no adhesive is required. The tape is not designed as a sole insulation. "Scotch" plastic electrical tape No. 33 is recommended as the outer wrap for protection against moisture, weather, and abrasion. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn.

Circle No. 5 on Reply Card



HERMETICALLY SEALED PROBE (foreground) transmits ultrasonic waves to electronic computer (rear) for continuous viscosity measurements

Viscosities Recorded Ultrasonically

The "Ultra-Viscoson" employs ultrasonic principles to record viscosities. The measurements are continuous and automatic. An hermetically sealed probe, the size of a fountain pen, contains no moving parts and operates to 650° F., 10,000 atm. pressure and can be installed permanently in pipe lines, process vessels, or used in test tubes and beakers. The electronic computer, which can be located up to 1 mile from the probe, indicates viscosity of Newtonian materials from 0-50,000 centipoises x gms./cc. in four decades: 0-50, 500-5000, 50000. Apparent viscosity of non-Newtonian materials can be measured over a much greater range. Viscosity is determined by the use of ultrasonic waves applied to the probe. The electronic computer converts the probe output instantly into viscosity measurements on a meter, recorder or controller. The Ultra-Viscoson can be used to actuate automatic controllers to maintain a blend of several lube oil fractions at a desired viscosity. This is now largely done by tedious batch techniques checked by frequent laboratory samplings. The instrument is now being used in research laboratories to study properties of high polymers. Effects of catalysts, polymerizers, pressure, temperature, time and other variables are being studied. Thermosetting and thermo-plastic materials are studied from the liquid through the solidification range to the solid. Any system of viscosity measurement can be furnished for explosion-proof service with the Ultra-Viscoson. Rich-Roth Laboratories, 673 Connecticut Blvd., East Hartford 8, Conn.

Circle No. 6 on Reply Card

Electronic Control Relay Works With Differential Transformer

An electronic control relay has been designed to operate in conjunction with a differential transformer transmitter. The transmitter may be one of the numerous types available, e.g., pressure, flow, motion, or force. To obtain control of any variable, the transformer is adjusted so that its zero position is at the exact point of the desired control. This position is sensitive to less than .0001 in. As the armature of the transformer is moved off this null point by a change in the variable, a signal is generated having amplitude and phase definition. Operation of control relay is not affected by normal line voltage variations and it can be installed up to 5000 ft. away from the source of the measured variable. Chassis of the relay is compact, having all working and plug-in components easily accessible on top of unit. Automatic Temperature Control Co., 5200 Pulaski Ave., Philadelphia 44, Pa.

Circle No. 7 on Reply Card

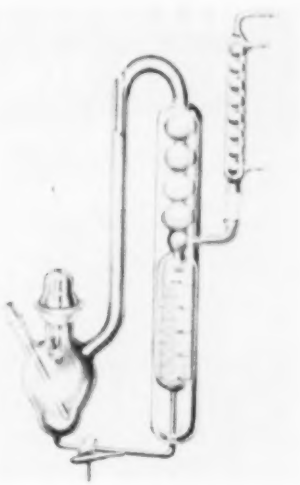
Chemically Inert Carboys Meet Test Requirements of ICC

As shown in the photograph, these "Plaxpak" carboys have passed the supreme test. Results of tests such as this reveal that although squeezed out of shape, the bottles were not punctured, and resumed their original shape after a "rest" period. Blow-molded in one piece of flexible polyethylene, the bottles are used in unique plywood-jacketed carboy containers. They have also passed tests necessary for Bureau of Explosives recommendation for Interstate Commerce Commission approval to ship hydrofluoric acid and electrotyte sulfuric acid solution. The chemically inert carboys are ideally suited to packaging such products as industrial acids (e.g., acetic, hydrofluoric, fluoboric, muriatic, sulfuric, and formic), caustic soda solution, hydrogen peroxide, liquid pharmaceuticals, photographic chemical solutions and many other liquids. It is estimated that the use of the unbreakable carboy will lower the transportation rate for shipments of bulk materials as much as 20%. Insurance rates are expected to decrease also. The new 15 gal. carboy is round and the entire polyethylene-plywood carboy unit weighs only 29 lbs., compared to an approximate weight of 70 lbs. of glass carboy bottles with their cases, of similar capacity. Also available is a 6½ gal. unit which weighs about 17 lbs. The walls of the polyethylene bottle will simply flex and expand but not crack if the contents freeze. Similarly, at high altitudes, the bottle's flexibility allows it to adjust to stresses imposed by unequal atmospheric pressures. Plax Corp., Hartford, Conn.

Circle No. **8** *on Reply Card*

Still Obtains True Equilibrium Accurately and Inexpensively

A "Flash Vaporization Equilibrium Still" is said to obtain equilibrium flash vaporization data for petroleum mixtures as easily as determining ordinary boiling point data. This is accomplished by the design of a modified recirculation type Othmer Still. The manufacturer states that the still always obtains true equilibrium, which is normally not the case in continuously operated pilot plant equipment. The still, a compact unit which may be set up on a laboratory bench top, has an initial cost substantially less than those of the continuous type. Minimum quantities of charge material are required per determination, e. g., 500 to 2000 ml., compared with about 2 bbls. for the continuous type. The still allows the determination of the initial boiling point of the mixture and all points of vaporization up to about 92%. Emil Greiner Co., 20-26 N. Moore St., New York.



Circle No. **9** *on Reply Card*

DID YOU MISS THESE?

The following items, reviewed originally in the March issue, have aroused considerable interest. They are repeated briefly as a service to those who might have missed them the first time. For details or literature, use the regular Reply Cards in this issue.

Flow Meter Applications

Bristol's "Series 500" Flow Meters. Bulletin F1605; 10-page booklet describing electrical and mechanical instruments for recording, integrating, indicating, automatic control, and telemetering flow of steam, water, air, gas, oil, solutions, and other fluids; operating principles, primary devices for flow measurement, recording charts, accessories, and sketches of typical applications. The Bristol Co. Waterbury 20, Conn.

Circle No. **10** *on Reply Card*

Scale and Corrosion Control

Organic Methods of Scale and Corrosion Control, 6th edition. 40-page bulletin discusses chemistry of water treatment in boilers, and the chemicals used for scale prevention, corrosion control, inhibiting of caustic fracture, prevention of wet steam, foaming or priming, and production of pure steam from the standpoint of minimum content of undesirable gases, bacterial presence and effects determined by laboratory or field tests. D. W. Haering & Co., Inc., P. O. Box 6037, San Antonio, Tex.

Circle No. **11** *on Reply Card*

Micro Flow Meter Can Measure Rates from 6 to 105 ml./min.

Both the high (1000 psig.) and low (100 psig.) pressure models of a new variable-area flow meter have maximum rates of 6-105 ml./min. for water, and 90-610 ml./min. for air at 20° C. They use a rotating float in a tapered glass tube with a fused-on, solvent-proof scale in millimeters. Low pressure model uses neoprene gaskets; high pressure model has a choice of neoprene or teflon. Both can be had in brass or Types 303 and 316 stainless steel. Floats come in plastic, aluminum, stainless steel and gold; nickel and platinum can also be supplied. Technical Equipment Co., 4348 San Pablo Ave., Emeryville 8, Calif.

Circle No. **12** *on Reply Card*

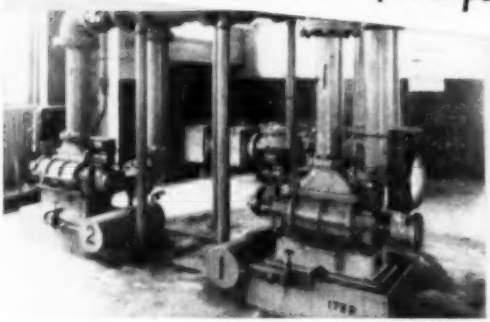
Laboratory Vac-Pressure Device Uses Cartesian Diver Principle

Designed for automatic vacuum and pressure control in the laboratory, an all-glass, "Cartesian Manostat", the Greiner Manostat No. 7, has been made available. Once vacuum is set on the device, the system may be shut down without disturbing the setting. It eliminates the necessity of complicated electrical and mechanical systems, or additional equipment of any kind. Glass construction provides corrosion resistance. Emil Greiner Co. 20-26 No. Moore St., New York, N. Y.

Circle No. **13** *on Reply Card*

MEASURE THESE VALUES WHEN YOU BUY METERS

Accuracy·Capacity·Compactness



Part of an installation of nine R-C Positive Displacement Meters in large chemical plant. Capacities from 3,000 cfh to 130,000 cfh.

Industrial buyers rate R-C Positive Displacement Meters "tops" in these basic essentials.

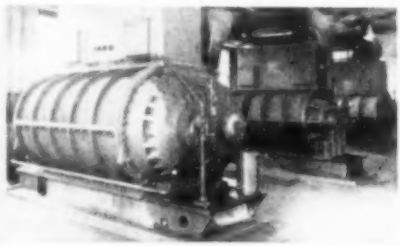
Accuracy—Not affected by pressure, wide variations in loads or other variables. Simple design, with no vanes, valves or small parts, results in maintained accuracy over long years of operation.

Capacity—from 1,000 cfh to 1,000,000 cfh in one unit, to meet practically any industrial metering requirements. Ample ability to absorb overloads.

Compactness—first for foot of capacity, R-C Meters are the smallest made for industrial use. Can be "tucked away" in relatively small space without loss of valuable production area.

These values have long been proved by large and small industrial plants and public utilities. More R-C Meters are used by gas producing plants, for their own manufacturing and for commercial customers, than any other make. For details on sizes and construction, ask for Bulletin 10-R-11.

ROOTS-CONNERSVILLE BLOWER CORPORATION
524 Texas Avenue, Connersville, Indiana



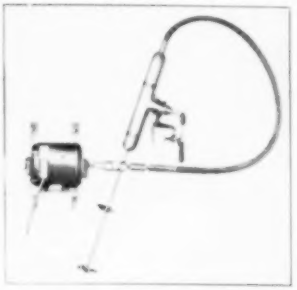
Three large R-C Meters in public utility plant. Unit in foreground has capacity of 1,000,000 cfh.

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

What's New!



Portable Mixer Has Flexible Drive Shaft for Easy Handling

An unusual departure from the conventional design of portable mixers is provided in the new "Pie-Flex" portable mixer and agitator. Instead of the usual shaft with propeller at one end and motor at the other, it consists of a propeller shaft connected with its motor by a flexible drive shaft. The flexible connection is quickly detachable from both motor and propeller. The design reduces the customary weight by more than half, it is said, and results in a well-balanced, easily-handled mixer. The mixer can be mounted and adjusted to desired angle by a lever-operated positioning device without any tools. No special motor is required—any standard horizontal motor can be used. In the case of hazardous operations, it can be mounted out of reach of flammable or explosive vapors; if necessary in an adjoining room. Pie-Flex is available in two models: P1 with a propeller shaft ⅝ in. in diameter, and P2 with a ¾-in. diameter. Standard length of flexible shaft is 96 in. long, but longer shafts can be supplied if specified. Process Industries Engineers, Inc., Pittsburgh, Penna.

Circle No. **14** *on Reply Card*

Self-Supporting Panelboards Have Deep Wing Panel Design

Where double faced instrument boards and walk-in type cubicles are desired the "Falstrom Deep Wing Panel" meets the requirements. Its design permits control panels to be placed away from valuable wall space, and where they can be most advantageously located. The unit is made of completely formed steel, usually 3-16" to ¼" in thickness, with return edges at top and bottom of 2" and side wings from 12" to 18" or wider for special purposes. These wings serve as supports and can also be used to mount terminal blocks and other electrical or mechanical equipment. Doors and top can be added to the assembly if future needs require. Falstrom Co., Falstrom Court, Passaic, N. J.

Circle No. **15** *on Reply Card*

KOCH OFFERS YOU

the KOCH KASKADE
FRACTIONATING TRAYS
THE KOCH KASKADE fractionating tray is the most economical device yet developed for distillation, absorption or liquid-liquid extraction. The use of this high-capacity tray, which results in smaller and lighter weight towers, saves refinery and chemical plants 20% to 40% in the total cost of complete tower installations. In addition to increased capacity, over 200 world-wide installations have proved the Koch Kaskade tray has as much as 25% better efficiency than the conventional bubble tray. Maintenance of the Koch Kaskade tray has been found to be less expensive than the bubble tray. The Koch Kaskade tray is inherently more streamlined and has no stagnant areas in which foreign material can collect. Cleaning cycles have been lengthened as much as 750% by replacing bubble trays with Koch Kaskade trays.
HOW THE KOCH KASKADE TRAY FUNCTIONS

This Brochure of the NEW

"BENTURI"-TYPE KASKADE FRACTIONATING TRAY

— which has been acclaimed thruout the process industry as *the successor to the bubble tray.*

You will be interested in this brochure telling how and why consistently higher capacities and efficiencies are obtainable.

MAIL TODAY

KOCH ENGINEERING CO., INC.
321 WEST DOUGLAS AVE.
WICHITA 2, KANSAS

Gentlemen:

Please send us your Brochure No. 629 on the new Koch "Benturi"-type Kaskade tray.

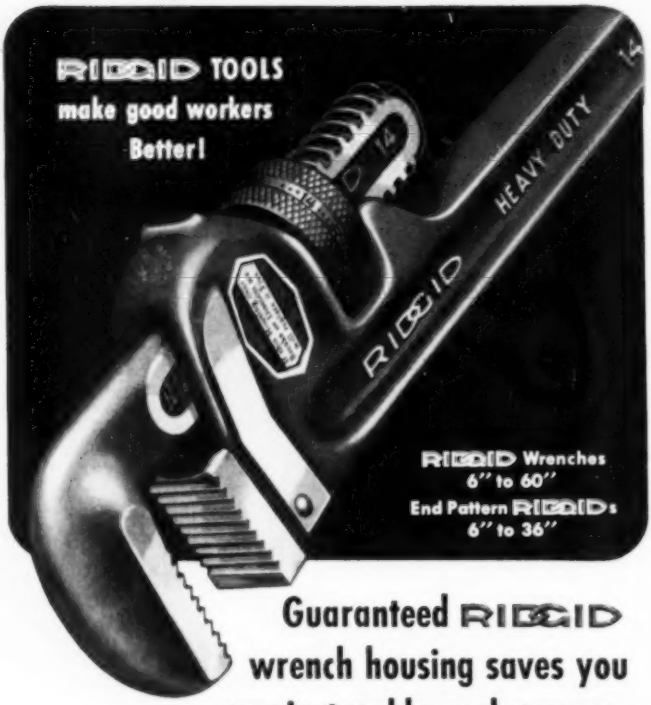
Name _____

Company _____

Address _____

City _____ *State* _____

Why Most Pipe Fitters Buy RIDGID Pipe Wrenches



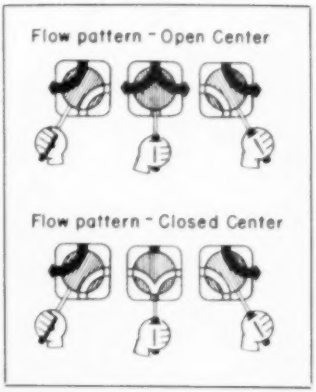
Guaranteed RIDGID wrench housing saves you repair trouble and expense

* It's an extra fast easy wrench to work with, too—handy pipe scale on hookjaw, adjusting nut spins easily to pipe size, comfort-grip handle.
* Special alloy jaws both replaceable—won't slip or lock on pipe.
* Safe powerful malleable housing and I-beam handle.
* Save money, make work easier—buy RIDGID, world's most popular pipe wrench, at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

★ ★ ★ RIDGID Work-Saver Pipe Tools ★ ★ ★

What's New!



Manipulator Valve Gives 0 to 3000 PSI Service

In the operation of this new control valve it is important to understand the functioning of its "Shear-Seal" principle. The tubular sealing members are so designed that they maintain a balance between the line pressure and the sealing force. Actuation of the valve takes place along the path of least resistance, by shearing the stream between two lapped members. This, in conjunction with generous ball bearings in the valve housing, provides extremely free handle movement for manipulating and inching cylinders and hydraulic motors. Another requirement often asked of manipulator valves is an absolute shut-off to prevent creeping. The manufacturer claims that this demand is met because the lapping action of the sealing members actually improves the sealing qualities in service. Valves come in normally open and normally closed flow patterns from ¼ in. to 1 in. pipe size, and for manifold mounting. The valves can accommodate pressures from 0 to 3000 psi. Barkslale Valves, 1566 E. Slauson, Los Angeles 11, Calif.

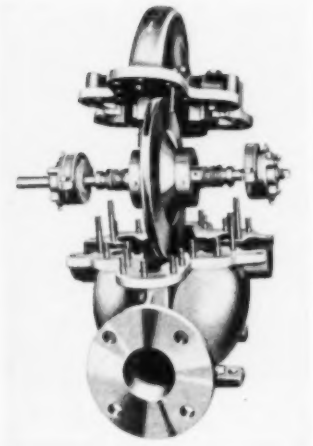
Circle No. **16** *on Reply Card*

Portable Viscometer Is Available In Explosion-Proof Construction

A new model of the portable eight-speed Model LVT viscometer is capable of measuring any viscosity between 0.5 cps and 2,000,000 cps with extreme accuracy when equipped with a "UL Adapter". Its 200 to 1 ratio of speeds starts at 0.3 rpm. This model may also be secured with explosion-proof construction. This modification adds very little to the instrument's weight and bulk and thus does not affect its portability. The viscometer is accompanied by a set of suitable spindles, a convenient spindle holder, and a compact carrying case which can contain both the viscometer and the spindle holder

when not in use. Determinations are secured directly in centipoises by inserting the instrument's spindle in the material to be measured, flicking on a switch, and reading the dial. Brookfield Engineering Laboratories, Inc., Porter St., Stoughton, Mass.

Circle No. **17** *on Reply Card*



Standard Mechanical Shaft Seals Permit Improved Pumping Service

The outstanding feature of a new line of horizontal, split-case, general service centrifugal pumps is the use of standard mechanical shaft seals, instead of conventional stuffing boxes. Result is savings in floor space, shorter shaft lengths, improved performance characteristics and easier pump servicing. This line of pumps, designated as the "Type AS", is available in discharge sizes from $1\frac{1}{2}$ in. through 4 in. Capacity range is up to 750 gpm. and head range up to 230 ft. General application is for pumping water and clear liquids up to 200° F. where no solids are in suspension. By use of standard mechanical shaft seals, instead of conventional stuffing boxes, the manufacturer states that the pump shaft of the pump is shortened to $\frac{1}{3}$ the length of shafts in conventional pumps of the same size. All types of drives are available with the Type AS pump, including direct-connected electric motor through a flexible coupling, gasoline engine and steam-turbine drive. The entire rotating element can be lifted from the case for inspection, repair or replacement without disturbing pump alignment, or connections to the pump. Peerless Pump Div., Food Machinery and Chemical Corp., 301 W. Ave. 26, Los Angeles 31, Calif.

Circle No. **18** *on Reply Card*

What is 100% Safe?

Anything less than 100% safe is 100% UNsafe.

This fellow's lucky, in a way. He *thought* his safety valves were 100% safe, and because they weren't, they might have killed him. Because those valves were *almost* safe, it's going to cost someone a lot of money.

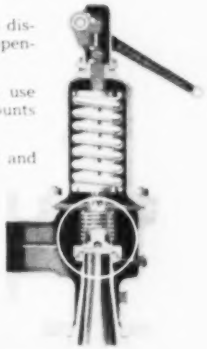
There's only one way to think of safety—think in terms of 100% or nothing. There's one sure way to *get* 100% safety—specify BalanSeal or FarriSeal Valves.

Why? Because they *can't* stick, plug or corrode. Critical working parts are permanently isolated from any contact whatever with the lading.

Because they're unaffected by back pressures in the discharge manifold due to its own operation or to the opening of other valves in the line.

Because these features make it possible for you to use smaller discharge piping, an economy which often amounts to substantially more than the cost of the valves.

You'll be interested in the engineering of BalanSeal and FarriSeal Valves—design which is rapidly gaining acceptance in hundreds of successful installations.



Ask for our "8-Minute Brief."

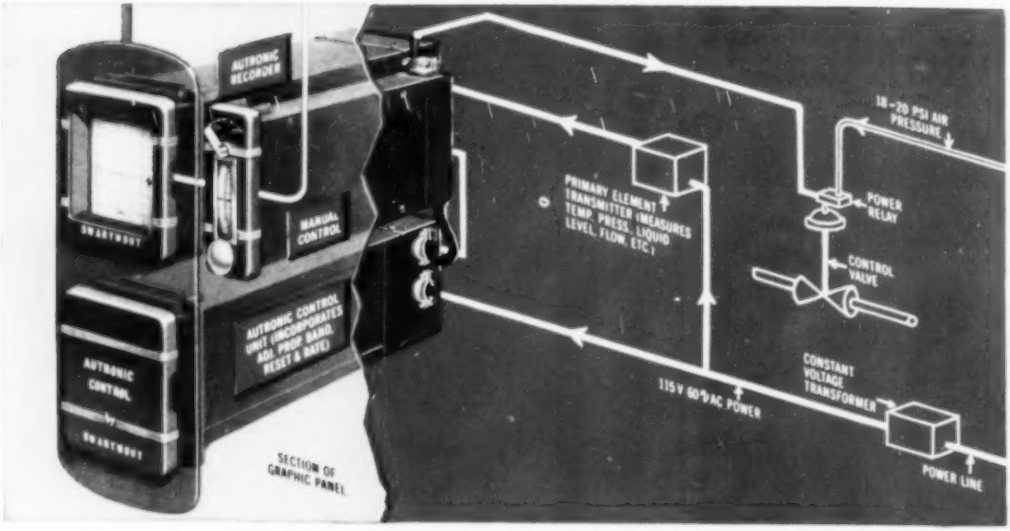
Your Safety's REAL With FarriSeal

Farris ENGINEERING CORP.

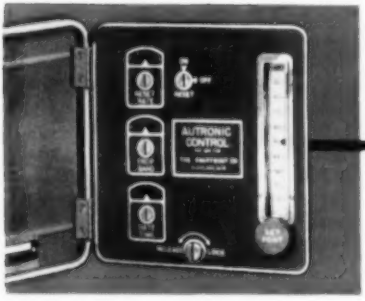
430 COMMERCIAL AVE., PALISADE PARK, N. J.

(To obtain more data on advertised products see page 696)

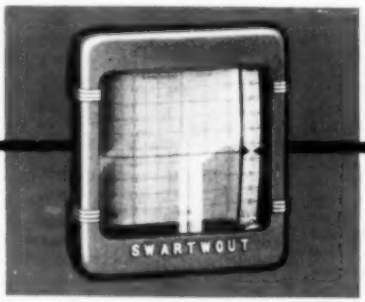
Miniature all-electronic system for instantaneous measurement and control of process variables...


AUTRONIC RECORDER
SWARTWOUT
MANUAL CONTROL
AUTRONIC CONTROL UNIT (INCORPORATES ADJ. PROP. BAND, RESET & RATE)
AUTRONIC CONTROL by SWARTWOUT
SECTION OF GRAPHIC PANEL
PRIMARY ELEMENT & TRANSMITTER (MEASURES TEMP. PRESS., LIQUID LEVEL, FLOW, ETC.)
18-20 PSI AIR PRESSURE
POWER RELAY
CONTROL VALVE
CONSTANT VOLTAGE TRANSFORMER
115 V. 60 ~ AC POWER
POWER LINE

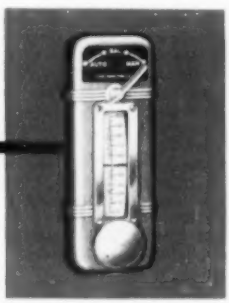
1 Regardless how fast a pneumatic or electro-mechanical system may function, it cannot compare with the *instantaneous, all-electronic* response of the Swartwout Autronic Control System. Here's why. Since transmission of information throughout the system is by *electrical means only*, there is no mechanical motion . . . no slide wires, boosters or motors to initiate control action . . . no control air lines from primary element or to final element. Hence the Autronic Control System *spans distance between primary and final elements without interval* —for closer, more accurate control



2 **AUTRONIC CONTROLLER**, heart of the system, has no moving parts. Proportion, reset and rate-action adjustments, with or without built-in set-point adjustment. Extremely compact, plug-in type units are interchangeable, can be used direct or reverse-acting.



3 **AUTRONIC RECORDER** operates without slide wires or other contacting mechanisms. Electronically controlled pen gives true linear trace. Unit holds 1-month supply of standard 3-inch linear or square root chart paper. Set-point adjustment optional with Autronic Recorder.



4 **AUTRONIC MANUAL CONTROL** makes bumpless changeovers simple. No gauges to synchronize, no readings to remember because indicator shows *difference* between actual and desired output.

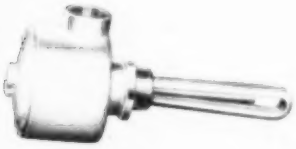
Swartwout *Autronic* **CONTROL SYSTEM**

SEND FOR BULLETIN A-701 • THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

Fork Truck Attachment Eases Operator's Drum Up-ending

An economical hydraulic drum up-ender attachment has been developed which permits fork truck operators to pick up, transport, stack and empty heavy drums without leaving their seat. Drums can be rotated 90 degrees for vertical or horizontal stacking, or tilted 45 degrees below horizontal for emptying at any height within the lift range of the truck. The attachment consists of shoes which are "pinned" to the forks. Mounted on the shoes are pivoted rubber-faced grab plates which clamp around the drum and hold it firm. The up-ending operation is accomplished through a hydraulic cylinder mounted on one of the shoes. Operation of the hydraulic cylinder builds up pressure in an actuating accumulator mounted above it, which is used to return the drum to an upright position. To demount the unit, the operator simply removes the two lock pins, unsnaps one quick-detachable hydraulic hose coupling, and slides the up-ender off the forks. Baker-Raulang Co., Baker Industrial Truck Div., 1250 W. 80th St., Cleveland, O.

Circle No. **19** *on Reply Card*



Electric Heaters Guard Against Corrosive and Explosive Vapors

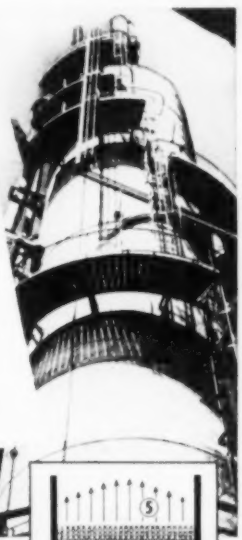
Improvement of two industrial electric heaters has been announced. The new construction is intended to give longer, safer usage of the units in the presence of corrosive and penetrating vapors. Type ARMT (illustrated in photograph) screw-plug unit with explosion-proof or vapor-tight terminal box is now available with wider built-in thermostatic range. With brass or copper construction for water heating the range is from 50° to 250° F.; with steel for oil heating it is 150° to 550° F. The type used for oil heating has a reduced heat intensity to prevent carbonization of oil on the sheath of the heater. The unit is available with 2 and 2½-in. standard pipe thread fittings from 1.5 to 10 kw. Heated length of unit ranges from 7¾ to 48 in. The built-in thermostat simplifies installation and wiring. Design of the type TBL electric tank heater now includes a vapor-tight terminal box as a standard feature. Heavy duty "Chromalox" tubular elements are welded to the sealed, electrical connection housing and the wiring is brought out to the terminal box through a thick-walled steel pipe. Units are available in steel, alloy, or stainless with ratings from 3 to 7.5 kw. Heated height ranges from 11⅛ to 43¾ in. E. L.

YOU, TOO, CAN GET

More Throughput

WITH

METEX MIST ELIMINATORS

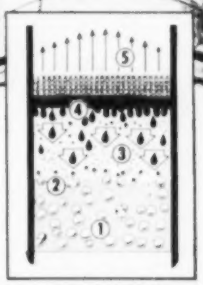


From the recovery of liquids entrained in discharge gases to the removal of contaminators to further processing, these simple knitted-wire pads are daily contributing to greater on-grade throughput, increased efficiency and lowered costs in refineries from coast to coast.

Metex Mist Eliminators do just one thing — remove liquids entrained in gases. The diagram shows how they are doing it in stills, towers, cats, knock-outs, evaporators and other vessels.

Efficiencies 95% and better • Little if any pressure drop • Easily installed in existing equipment • Made of practically any metal • No valves or moving parts to service.

Worth looking into, isn't it? For full information, write for free copy of "Metex Mist Eliminators," an 8-page brochure that's packed with facts.



HOW IT WORKS

(1) Gas passes through liquid. (2) Bursting gas bubbles produce fine spray of liquid droplets. (3) Droplets are entrained in rising stream. (4) Droplets coalesce on knitted-wire surfaces to form large drops that fall back against the flow. (5) Gas passes on, freed from entrainment. The liquid is returned.

METAL TEXTILE CORPORATION

KNITTERS OF WIRE MESH FOR MORE THAN A QUARTER CENTURY

METEX

631 East First Avenue, Roselle, N. J.

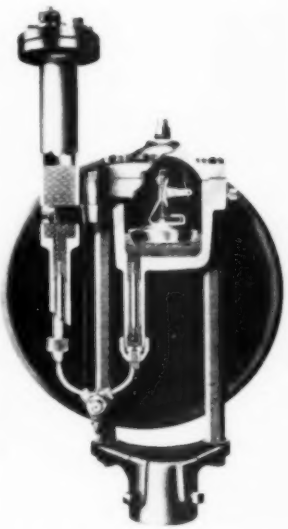
(To obtain more data on advertised products see page 696)

Wiegand Co., 7605 Thomas Blvd., Pittsburgh 8, Pa.

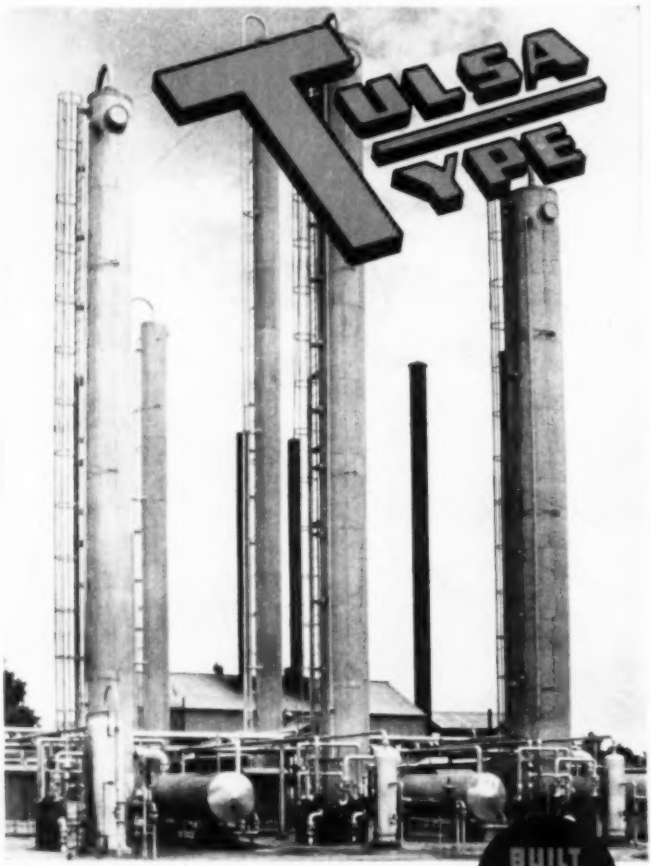
Circle No. 20 on Reply Card

Design Improvements Result in High Accuracy in Flow Meters

Higher sustained accuracy and easier maintenance are the results of the five basic improvements in the design of the new Foxboro flow meter. The pressure-seal bearing is lubricated at the factory to eliminate periodic lubrication maintenance. Leak-proof at working pressures, the bearing uses no springs and needs no mechanical adjustments. Bearing body and associated parts are interchangeable. Also interchangeable are the plastic check floats which are kept clean by complete submersion in mercury. A new stainless steel ball-plug and seat prevents clogging and locking. The improved U-bend has metal-to-metal compression seals, tested at 10,000 psi, for full protection against mercury loss. Replaceable seats are now made of hardened stainless steel. There are no gaskets to replace. The damping plug is calibrated to simplify damping adjustments. With the plug set at drain position, the drain port, located at the low point in the U-bend, allows mercury to be completely emptied without spillage. A new type of stainless steel ball-chain, by which the powerful straight-line motion of the float is transmitted to the recording pen assembly, eliminates friction and errors of angularity. The Foxboro Co., Foxboro, Mass.



Circle No. 21 on Reply Card



TULSA TYPE Deethanizer, Depropanizer and Debutanizer Columns in natural gasoline plant.

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

Trade Literature

Petrochemical Instrumentation

Instrumentation, Vol. 5, No. 6, 1952; contains two articles of interest to petrochemical plant instrument men: 1) Dow's ethylene purification process integrated with central control system; 2) control equipment employed in Celanese Corp. of America Chemcel plant at Bishop, Tex. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. 22 on Reply Card

Water Conditioning Equipment

Tray-Type Deaerating Heaters, Bulletin WC-106; 12-page booklet explains the principles of successful deaeration and the essential elements of a deaerating heater in water treating processes; illustrated by detailed drawings identifying all parts, flow diagrams, and photographs of typical heater installations. Graver Water Conditioning Co., Dept. 25-6, 216 W. 14th St., New York 11, N. Y.

Circle No. 23 on Reply Card

Laykold
ASPHALT SPECIALTIES

WEATHERCOAT protects refinery insulation

WEATHERCOAT is specified by leading refinery designs engineers.*

WEATHERCOAT is the standard for maintenance in leading refineries.*

Make these tests:

- Troweling Ease—Cold
- Flexibility with Toughness
- Freedom from Shrinkage
- Mixes with Sand for Scratch Coat (or buy ready-mixed MASTIC WEATHERCOAT)

Send for information. Prove to yourself that WEATHERCOAT gives the best yield and is the easiest to apply.

*Names on request.

AMERICAN Bitumuls & Asphalt COMPANY

200 BUSH ST., SAN FRANCISCO 4, CALIF.

Providence 14, R. I. Perth Amboy, N. J.
Baltimore 3, Md. Columbus 15, Ohio Mobile, Ala.
Tucson, Ariz. Seattle, Wash. St. Louis 17, Mo.
Baton Rouge 2, La. Inglewood, Calif.
Oakland 1, Calif. Portland 7, Ore.
Washington 6, D. C. San Juan 23, P. R.

What's New!

Synthetic Lubes and Waxes

Properties of Kel-F Oils (and Plasticers) Greases and Waxes, Technical Bulletin No. 5-1-52; four-page folder gives various physical properties of Kel-F greases, oils and waxes, useful in sealing medium applications where chemical inertness and resistance to high temperatures are important; two graphs are included, one illustrates the relative kinematic viscosity-temperature characteristics of the oils, the other traces the density-temperature relationships for representative samples of the oils, greases and waxes. M. W. Kellogg Co., Chemical Mfg. Div., P. O. Box 469, Jersey City 3, N. J.

Circle No. **24** *on Reply Card*

Dual Temperature Insulation

Fiberglas Dual Temperature Pipe Insulation, Bulletin No. INI C3; four-page folder gives description, physical properties, application procedures and selection table of a fibrous glass bonded insulation material with a thermosetting binder, accurately preformed in easy-to-apply hemi-cylinders and segments that fit all standard pipe and tubing sizes. Owens-Corning Fiberglas Corp., Toledo 1, Ohio.

Circle No. **25** *on Reply Card*

Electroplating Fights Corrosion

Practical Nickel Plating, Bulletin No. EZ-92 9; 44-page booklet contains many illustrations, tables and charts providing the designer, specifying engineer and user with basic information on electroplating and detailed information on nickel plating and its practices; thickness and type of nickel deposit for adequate service life in many corrosion-resistant, industrial and electroforming applications are discussed. International Nickel, Dept. EZ, New York 5, N. Y.

Circle No. **26** *on Reply Card*

Industrial Wastes

Industrial Wastes Inventory, 1951; 17-page report on the first phase of an overall program to determine volumes, characteristics and strengths of industrial wastes discharged in the Interstate Sanitation District comprised of New York, New Jersey, and Connecticut; 65% of total waste discharge attributed to petroleum refinery industry. Interstate Sanitation Commission, 110 William St., New York 7, N. Y.

Circle No. **27** *on Reply Card*

Induction Motor Construction

Large Vertical Induction Motors, Bulletin No. 05B7629; four-page folder gives characteristics of vertical solid shaft induction motors, open, self-ventilated type, with motor ratings in 40 C, 60 cycle from 60 hp., 200 rpm. to 800 hp. and larger at

Heat Control in Oil Refineries

In an industry where the slightest slip, can start a fire with terrific losses, heat control is of great importance.

To meet these difficult heat control conditions, The Burling Instrument Co. designed a Temperature Control, which is operated pneumatically. It permits control or safety cut-off of temperatures as high as 1800° F and of sub-zero temperatures down to 300° F or lower.

Burling TEMPERATURE Controls

No danger of electric sparks, and control within plus or minus ½ of a degree, with supervision practically eliminated.

Either the Burling Pneumatic Control model H A or the Burling Valve type model Y, will help solve the most difficult heat control problems in the Gas and Oil Refining Industries.

Send for our new catalog G-17. It will give you more details.

Temperature Controls since 1935

BURLING INSTRUMENT CO.

4 Vose Ave. South Orange, N. J.

(To obtain more data on advertised products see page 696)

Thermo-COUPLES

with Quick Coupling Moistureproof Connectors

When thermocouple connections are broken frequently and are exposed to moisture or are located outdoors, you can quickly connect thermocouples to extension wires and seal the connections against moisture by installing thermocouples with quick coupling connectors — covered with neoprene, slip-on jackets. Illustrated is a Protected Thermocouple with plug and jack connector and moisture-proof jacket. Available in all standard thermo-elements.

These and many other types of thermocouples and connectors are described in our catalog I.

Write for your copy

Thermo Electric Co. Inc.
FAIR LAWN NEW JERSEY

FOR SALE!
HYDROGEN COUNTER TUBES $125.00
(Guaranteed for One Year*)

Filling	Hydrogen
Operating Range	-40° F to 300° F
Operating Voltage	1075 Volts
Plateau	300 Volts
Slope of Plateau	Depends on quenching circuit
Cathode Material	Copper
Effective Cathode Dimensions	3" lg. x 1¼" ID
Type of Quenching	External Quenching

*Guaranteed for one year except for mechanical damage and failure of quenching circuit.

FREE! Safety Code for Use of Radium. Write today.

INSTRUMENTS, INC.
122 N. Madison Tulsa 6, Okla.

Non-Ferrous

WELDING DESIGN and FABRICATION

- Monel Metal
- Stainless Steel
- Glass-lined Tanks
- Aluminum-clad Metals
- Cadmium-lined & Galvanized Vessels

Experience in meeting the exacting requirements of our military contracts is a guarantee to customers of our ability to meet highest standards in all types of non-ferrous and special alloy fabrication. Heliarc and "sigma" semi-automatic inert gas welding for the latter mean special qualifications to meet the most exacting requirements.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

What's New!

1800 rpm; construction features given on thrust and guide bearings, bearing housings and enclosed construction assembly. Allis Chalmers Mfg. Co., 836 S. 70th St., Milwaukee, Wis.

Circle No. **28** *on Reply Card*

Pump Instruction Booklets

Instructions for Installing, Operating, and Repairing Multi-Stage Centrifugal Pumps, Bulletin 08X7780, and, *Instruction Book for Installing, Operating, and Repairing Single Stage-Single Suction Centrifugal Pumps*, Bulletin 08X7813; 47 and 24-page booklets, respectively, covering such late developments as "Magic-Grip" couplings, universal joint couplings, and mechanical seals, with each containing a handy reference table explaining how to locate pump troubles with possible causes and cures; includes large size section drawings for easy reference. Allis-Chalmers Mfg. Co., 836 S. 70th St., Milwaukee, Wis.

Circle No. **29** *on Reply Card*

Applications of Infrared Analysis

Product Control Through Infrared Analysis; eight-page booklet tells how six leading chemical manufacturers successfully applied infrared analysis to their product control problems such as detection of water in freon, gamma isomer content of benzene hexachloride, assay of chemical products, and plant production control for an insecticide manufacturer. Perkin-Elmer Corp. Norwalk, Conn.

Circle No. **30** *on Reply Card*

Value of Pipeline Strainers

Self-Cleaning Pipeline Strainers, Bulletin 252; four-page folder describes the value of self-cleaning pipeline strainers in sediment control, uses in steam traps, reducing valves, air tools, pumps, and temperature regulators; construction features, specifications and prices included. V. D. Anderson Co., 1935 W. 96th St., Cleveland 2, O.

Circle No. **31** *on Reply Card*

Uses of Hydrogen Peroxide

Progress in Peroxides, Bulletin No. 36; 26 pages on the various uses of hydrogen peroxide and peracids, e.g., oxidation and reduction, and organic synthesis reactions such as epoxidation, hydroxylation, preparation of steroids, and quinone formation; 40 literature references cited. Buffalo Electro-Chemical Co. Inc., Station B, Buffalo 7, N. Y.

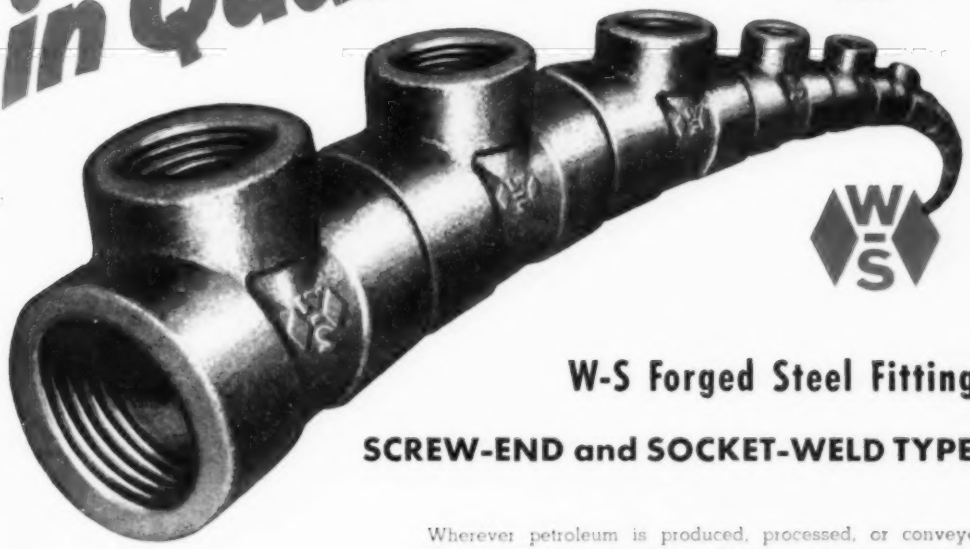
Circle No. **32** *on Reply Card*

Fluid Hydroforming

Heat Engineering, Vol. 27, March 1952; a five-page article describes the advantages of this new process that catalytically reforms low-octane heavy naphtha into high octane gasoline at high yield; flow diagram included. Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

Circle No. **33** *on Reply Card*

Quality... in Quantity



W-S Forged Steel Fittings

SCREW-END and SOCKET-WELD TYPES

Wherever petroleum is produced, processed, or conveyed, Watson-Stillman FORGED Steel Fittings mark the lines to lower operating cost and higher profits.

Quality—in Quantity—has earned and sustained the Watson-Stillman position of first-to-see when industry seeks a solution to a specific fittings problem. Despite an enormous increase in the use of its low service cost fittings, Watson-Stillman has never relaxed its concern for the metallurgical aspects of product development.

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What's New!

Automatic Temperature Controls

Burling Temperature Controls, Catalog G-17, 12-page booklet discusses temperature control functions, electrically operated mechanisms, and temperature controlled valves; among new electrical type mechanisms is the Model V-1, used where a vapor tight cover is required for special applications, including refrigeration. Burling Instrument Co., 5 Vose Ave., South Orange, N. J.

Circle No. **34** *on Reply Card*

Motor and Control Problems

Westinghouse Motors and Controls in the Chemical Processing Industries, Bulletin B-4792, 30-page illustrated booklet treats general application problems, such as corrosion and outdoor service, common to the chemical industry and shows how the coordinated application of motors and controls provides the solution. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Circle No. **35** *on Reply Card*

Water Conditioning Handbook

Permutit Water Conditioning Data Book; 116-page leatherette bound book, 5 x 7¼ in., covers such subjects as hydraulics, impurities in water, chemicals used in water treatment, specific gravities and chemical reactions; supersedes the 1949 volume, and contains 77 tables. Permutit Co., 330 W. 42nd St., New York 36, N. Y.

Circle No. **36** *on Reply Card*

Adjustable Flow Valves

Adjustable Flow Valves for Gas and Air, Catalog No. 713; eight-page brochure illustrates valves for burner control with adjustable flow characteristics which can be altered at various points of opening to obtain the desired amount of flow; includes construction features, air and gas capacities charts, engineering drawings with dimensions. Hauck Mfg. Co., 124-136 Tenth St., Brooklyn 15, N. Y.

Circle No. **37** *on Reply Card*

Pressure Output Regulated

Hagan Ratio Totalizer, Bulletin No. 5452; eight-page brochure describes a pneumatically operated control mechanism for accurately combining input signal pressures and spring forces to produce a single output signal pressure; engineering drawing supplies outline dimensions of the mechanism. Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa.

Circle No. **38** *on Reply Card*

Industrial Process Control

Centralized Instrumentation Unlimited, Bulletin No. 85-20; 32 pages describing conventional and graphic type panelboards, measuring and control instruments; freely illustrated with photographs of control equip-

ment, and diagrams of typical control systems. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **39** *on Reply Card*

Valve Design and Construction

Nordstrom Corrosion - Resistant Valves, Bulletin V-217, 32-page booklet describes various corrosion-resistant valves, alloys most effective in their construction, and typical applications; photographs, sectional drawings, dimensions and prices included. Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

Circle No. **40** *on Reply Card*

Vapor Condensers

D & E Vapor Condenser Model VS and *D & E Vapor Condenser Model VT*, two four-page folders, with two-page inserts, describes two new stainless steel vapor condensers, Model VT for condensing vapors through the tube side, and Model VS, on the shell side; engineering drawings and specifications included. Doyle & Roth Mfg. Co. Inc., 150 24th St., Brooklyn 32, N. Y.

Circle No. **41** *on Reply Card*

Floating Roof Tanks

Double-Deck Floating Roof Tanks, 12 page brochure describes advantages of storing petroleum products in floating roof tanks with emphasis on operating and construction features; illustrations and a tank dimensional table included. Graver Tank & Mfg. Co. Inc., East Chicago, Ind.

Circle No. **42** *on Reply Card*

Basic Process Control

Fundamentals of Instrumentation for the Industries, Bulletin No. 80-2; 128-page booklet covers the fundamentals of measurement, control and transmission of variables encountered in industry, with typical applications, nicely illustrated with photographs and engineering drawings. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **43** *on Reply Card*

Chemical Resistance Chart

Prufcoat Chemical Resistance Chart, Technical Bulletin Sheet No. 501; a single data sheet of laboratory and field tests showing resistance ratings of "Prufcoat Coatings" to some 69 corrosive chemicals (in concentrated or dilute form), useful for controlling deterioration of industrial floors, walls, ceilings, structural steel, tanks, pipes, ducts and machinery. Prufcoat Laboratories, Inc., 50 E. 42nd St., New York 17, N. Y.

Circle No. **44** *on Reply Card*

Literature Offered in this Issue's Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature offered in this issue:

ADDITIVES, corrosion preventive. Literature and technical information offered by Monsanto Chemical Co. See adv't p. 673.

ALUMINUM BRONZES, corrosion - resistant. Information offered by Ampco Metal, Inc. See adv't pp. 598-599.

BURNERS, oil-gas. Detailed literature offered by National Airoil Burner Co., Inc. See adv't p. 598.

CATALYST SUPPORTS. Samples offered by Norton Co. See adv't p. 678.

CATALYTIC CRACKING. *Kellogg*ram, "From Ratio Bridge to Riser-Flow" offered by The M. W. Kellogg Company. See adv't pp. 604-605.

CLEANERS & DESCALERS, tool entrained. Literature offered by Oakite Products, Inc. See adv't p. 686.

COMPRESSORS, centrifugal. Catalog, "Centrifugal Compressors for Industry" offered by Carrier Corp. See adv't p. 610.

COMPUTER, equilibrium, for engineering design examinations. Bulletin 25-286 offered by Beckman Instruments, Inc. See adv't p. 683.

EXPANSION JOINTS, gasketing type. Bulletin 35-1951 offered by Allentown District Steam Co., Inc. See adv't p. 600.

FANS, cooling tower. Bulletin 1501 offered by Hartzell Propeller Fan Co. See adv't p. 602.

FILTERS, absorption, for air lines. Bulletin B-1A offered by Bellinger Corp. See adv't p. 609.

FIRE PROTECTION equipment. Data offered by Pyrene Manufacturing Co. See adv't p. 679.

FITTINGS, welded. Catalog offered by Taylor Steel Tubes Co. See adv't facing p. 640.

FLOW METERS. Catalog 37 offered by Foxboro & Porter Co. See adv't p. 604.

FLOW METERS, motor-type, electronic. Descriptive literature offered by Hastings Instrument Co., Inc. See adv't p. 680.

FRACTIONATING TRAYS. "Better" type. Brochure No. 629 offered by Koch Engineering Co., Inc. See adv't p. 701.

GASOLINE STORAGE STABILITY. Paper entitled "Stability of Present-Day Gasolines" offered by E. I. DuPont de Nemours & Co., Inc. See ads to p. 606 and facing 606-607.

HEAT EXCHANGERS, air-cooled. Bulletin No. FF-A offered by The Fluor Corp. See adv't p. 579.

HEATERS, tubular. Bulletin & technical description offered by Selas Corp. of America. See adv't p. 695.

INSTRUMENTS, control. Composite Catalog 5000 offered by Minneapolis-Honeywell Regulator Co. See adv't pp. 580-581.

LININGS, refractory. Brochure RC-28A offered by Johns-Manville. See adv't p. 682.

METERS, positive displacement. Bulletin 40-B-1A offered by Rockwell-Connersville Blower Corp. See adv't p. 700.

PAINT, protective. Information offered by American Bitumuls & Asphalt Co. See adv't p. 597.

PAINT, rust preventive. Bulletin 720 offered by U. S. Stoneware Co. See adv't p. 671.

PAINT, rust preventive. Literature offered by Rust-Oleum Corp. See adv't p. 668.

PIPE CUTTERS, portable. Catalog, engineering & engineering data offered by Yorkey Tool Co., Ltd. See adv't p. 671.

PUMPS, casing jet. Bulletin 4000 offered by Penberthy Injector Co. See adv't p. 591.

PUMPS, jet ejector. Bulletin 4000 offered by Penberthy Injector Co. See adv't p. 591.

PUMPS, sump, explosion-proof. Bulletin 1629 offered by Penberthy Injector Co. See adv't p. 591.

MIST ELIMINATORS. 8-page brochure offered by Metal Textile Corp. See adv't p. 705.

RECTIFIERS, oxygen. Bulletin GEA-6 offered by The Hays Corp. See adv't p. 647.

SAFETY, for small refineries. Article 3 2nd offered by E. I. DuPont de Nemours & Co., Inc. See adv't p. 606.

SAFETY GUIDE, for use of fusible offered by Instruments, Inc. See adv't p. 700.

SEALS, mechanical. Bulletin No. 101P offered by Instrumentalist Corp. See adv't p. 661.

STEAM TRAPS. Bulletin 102 offered by W. H. Nicholson & Co. See adv't p. 661.

STEAM TRAPS. Information offered by The Clark Manufacturing Co. See adv't p. 670.

STEAM TRAPS, impulse. Free sample offered by Yarnall-Waring Co. See adv't p. 704.

TEMPERATURE CONTROL. Catalog 42-17 offered by Burling Instrument Co. See adv't p. 707.

THERMOCOUPLE CONNECTORS, electrical. Catalog 1 offered by Thermo-Electric Co., Inc. See adv't p. 706.

TUBING, coiled aluminum. Facts & technical data offered by Aluminum Co. of America. See adv't p. 620.

TURBINES, gear type, close-coupled. Booklet B-4336 offered by Westinghouse Electric Corp. See adv't p. 589.

VALVES, control. Catalog Section 105 offered by Black, Sivalls & Bryson, Inc. See adv't p. 661.

VALVES & FITTINGS. Catalog F-5 offered by Henry Vogt Machine Co. See adv't p. 593.

VALVES, pump. Catalog offered by Nash Pump Valve Co., Inc. See adv't p. 668.

VALVES, relief. "5-Minute Brief" offered by Fairis Engineering Corp. See adv't p. 706.

VALVES, small steel gate. Circular 511-1951 offered by Crane Co. See adv't p. 601.

For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

EDITORIALS

No Orchids for Bureau's Coal Hydrogenation Figures

WHILE greatly limited in the scope of its review of the Bureau of Mines estimates of coal hydrogenation costs, the recent report by Ebasco Services, Inc., New York engineering firm, does not support the Bureau's estimates of the cost of commercial plants. Neither does the Ebasco report, made at the request of the Secretary of the Interior, uphold the Bureau's proposed method of financing a full-scale coal hydrogenation enterprise for the manufacture of synthetic liquid fuels and chemical products. On some points Ebasco is quite critical of the Bureau's cost estimating technique.

By the terms of its contract with the Interior Department, Ebasco accepted without challenge the Bureau's estimates for cost of the raw material coal, of the catalyst and of chemicals used in processing. It also did not review the processing steps. It also accepted the Bureau's estimates of product output, together with the prices at which the products would be sold. Thus the Ebasco review of the coal hydrogenation cost estimates, to quote the foreword of its report, "was limited to specific phases of construction and operating costs, and to housing, markets for by-product chemicals and the financing program for a Wyoming and a West Kentucky plant."

The points authorized for review were chiefly those where there was a substantial difference in the cost estimates of the Mines Bureau and those made by the National Petroleum Council in its separate study of the commercial feasibility of coal hydrogenation plants under present economic conditions. However, by request of the Bureau, the NPC report was not made available to Ebasco in its study and the NPC findings were not referred to in its report.

In reviewing operating cost estimates for the proposed 30,000 b/d coal hydrogenation plant at Rock Springs, Wyo., Ebasco's figure for annual cost of operation, without profit and interest, is $55,773,000, as compared with an estimate of $50,219,000 for the Mines Bureau. Both estimates include a figure of $14,818,000 for cost of raw material coal, catalyst and chemicals, since Ebasco accepted the Bureau's cost estimate for these items. Excluding this figure from the two estimates, Ebasco's figure for other direct operating costs of the proposed Rock Springs plant is $18,807,000, while that of the Bureau is $11,710,000. The Ebasco estimate thus is around 60% higher than that of the Bureau. Approximately the same difference applies in the case of the West Kentucky plant.

In discussing the financing of commercial coal hydrogenation plants, Ebasco finds the indicated return for invested capital, from the Bureau's data, "so low as to make the private financing of the projects impossible." In order to attract equity investment, Ebasco believes the indicated return would have to be of the order of 14-16%. To produce such yearly returns it finds that net incomes for the proposed operations would have to be increased by possibly up to $50,000,000 in the case of the Rock Springs plant and around $40,000,000 in the case of the West Kentucky project. These increases alone are several times the estimated return for invested capital, as taken from the Bureau's cost and income data for the two plants.

In the Bureau of Mines two coal hydrogenation projects, as proposed, more than half the annual revenue would come from the sale of by-product chemicals.

These figures on volume of chemical products were not subject to check by Ebasco, which was asked, however, to determine the marketability of the specified amounts of chemicals. The engineering firm found that "the amounts of chemical co-products as specified could find markets by 1955 at prevailing prices." On the point of marketability of chemical products from coal hydrogenation operations extended to 8 plants of 240,000 b/d total liquid fuel capacity, Ebasco was not so sure.

One recommendation in the Ebasco report is that industry and outside consultants be called in, to provide a check of the methods employed and results obtained by the Bureau's research organization, before they are incorporated in final reports. Oil industry technologists have offered their services to the Bureau at various stages in its Synthetic Liquid Fuels Research Program, but they have been pretty much rebuffed. This very practical suggestion and other findings in the Ebasco report, if adopted by the Bureau in its further work in this field, will make for the development of a more sound program.—V.B.G.

Selling Job for API Committeemen

THE work of the various committees of the API Refining Division over the past several years has been of considerable practical benefit to operating refiners.

This work of the API Refining Division committees has built up until now about 100 men both from oil and equipment companies serve on these projects, putting in a great deal of time during API meetings and in fact throughout the year. It might well be accepted that the engineers and others who devote so much of their personal time and energy to the tasks could rest on their laurels once their work is accomplished and their reports or manuals prepared.

Unfortunately, such is not the case. Recent informal check of a few companies whose technical representatives have been active in the committee work shows these same companies have been among the most tardy in some instances in putting into use the techniques promulgated. There might be several reasons for this, among them the normal lethargy in changing accepted operating procedures.

In some cases it might also be that the API committeemen had not gone home from their meetings and put into their reports to their own plant managers and department heads the same enthusiasm as has gone into their committee work. The API committeemen may be called on to do more selling at home, in order to bring about the fullest use in the industry of the improved techniques they have worked out.—V.B.G.

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FOR RESEARCH AND DEVELOPMENT GROUPS interested in studying this important new chemical tool, experimental quantities of SULFAN are available. In addition, General Chemical has prepared four technical bulletins on SULFAN. Each one is packed with useful information. You will find them extremely helpful if your work involves sulfonations, or indicates their use. When writing for your copies, please fill in coupon completely, or make inquiry on your business letterhead.

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Bulletin SF-3—"Storage, Handling and Use of SULFAN"

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